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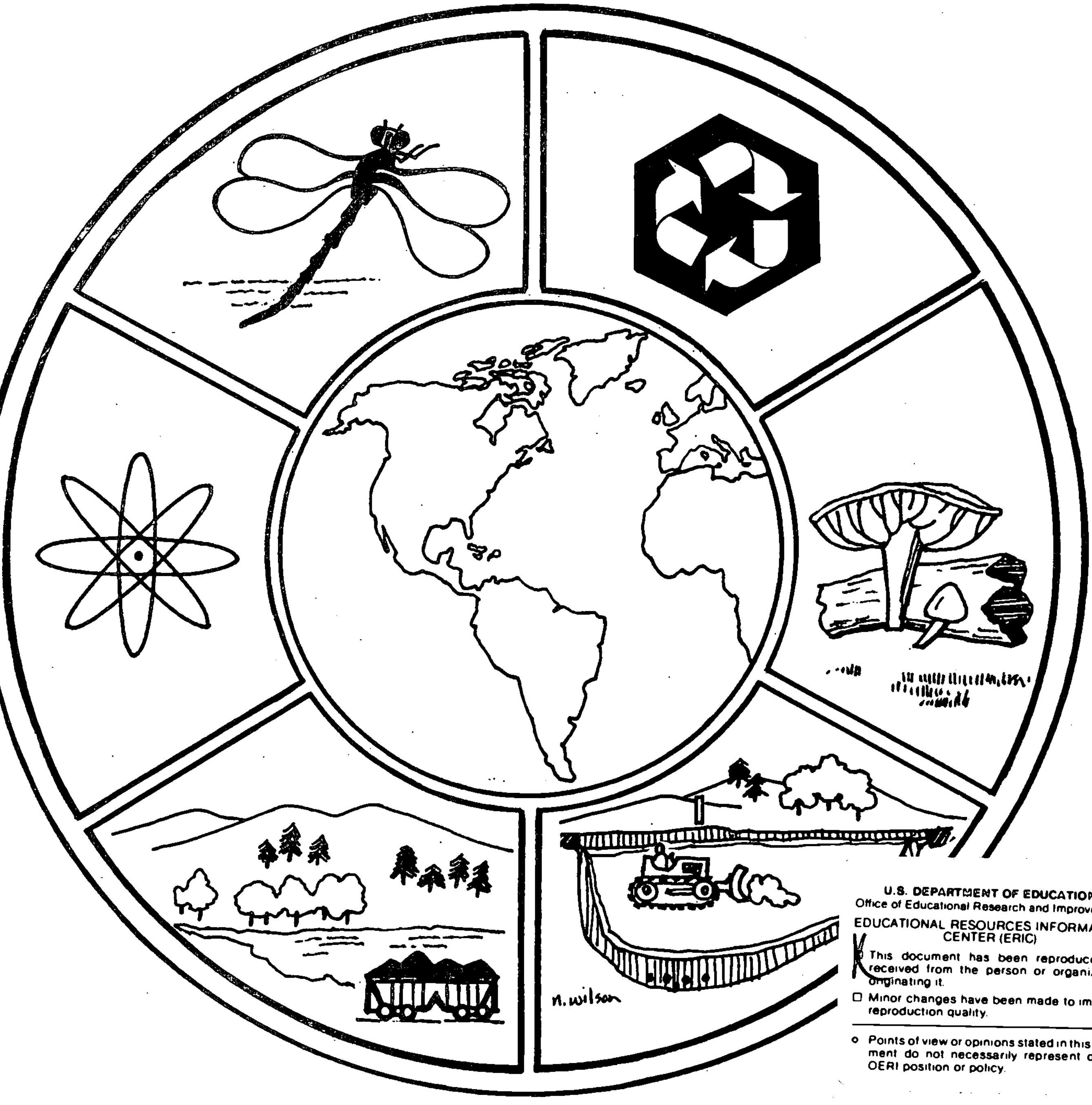
ABSTRACT

This guide contains a series of lessons for elementary school students covering environmental issues including waste reduction and recycling, decomposition and composting, landfills, natural resources, energy sources and conservation, and water quality. The lessons include an objective, background information, method, and activities for reinforcement. Each lesson emphasizes what people can do to lessen the impact of human beings on the environment. Through environmental education students become more aware and more informed. Each lesson contains references to provide a source of further information for teachers who wish to go into greater depth on a particular topic. The guide also provides a few illustrations that may be copied for students to color. (AIM)

# EARTH






# PATROL

## BRUKNER NATURE CENTER

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# EARTH PATROL

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# Preface

The Earth Patrol project began in May of 1991. Brukner Nature Center with funding from the Troy Foundation developed an environmental issues program for grades one through six which was field tested in all elementary schools in the Troy, Ohio school district.

Environmental Education is defined as a life-long process that encourages people to explore, raise questions, investigate issues and seek solutions regarding environmental and related social problems.

The Earth Patrol program is intended to increase the environmental awareness of the community through its children and to create an understanding of the size and complexity of todays problems with a willingness to work toward solving these problems and preventing new ones.

The topics chosen are environmental issues that are current and are receiving public attention. Information on environmental issues is constantly changing, but an effort has been made to get the most up-to-date information available. It is our intent that Earth Patrol will be a building block to help incorporate these topics into your school/classroom curriculum and to increase the environmental education of students. The lessons include an objective, background information, method, and activities for reinforcement. Each lesson emphasizes what all of us can do to lessen our impact on the environment. Through education we become more aware and informed. The more aware and informed we are of environmental issues, the more likely we are to put our knowledge into action.

A special word of thanks to Dr. Joe Heimlich of Ohio State University for his invaluable information, ideas, and time in reviewing Earth Patrol.

A thanks also goes out to Debbie Brill for proofing, computer entry, and her commitment to the finished product of Earth Patrol.

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# FIRST GRADE - LESSON 1
# THE 4RS:
# REDUCE, REUSE, RECYCLE, RETHINK

## OBJECTIVE:

*The students will learn the 4Rs of waste reduction, with an emphasis on rethinking. Students will also learn some of the problems associated with recycling.*

## PART I: BACKGROUND

### INTRODUCTION:

A 1991 study reported that the per capita waste burden was 7.1 pounds. Although each person generates approximately 4 pounds of waste each day, we also generate hidden trash. For example, when a person buys a jug of milk at the supermarket, they see only the plastic jug as waste. All of the milk jugs were also packaged in boxes and crates when they were shipped to the supermarket. The box, crate, and gasoline that were used to transport the milk all represent energy and resources. These are hidden wastes which increase the per capita waste burden in the United States from 4 pounds to 7.1 pounds per day!

The 4Rs can help lessen our production of solid waste while conserving resources.

### I. Reduce

The biggest step in reducing the waste stream is to consume less. With the increased standard of living after WWII, luxury items have become the norm. Making decisions about consumption based on our needs rather than our wants effectively reduces consumption.

### II. Reuse

The second step is to reuse products. Wash out containers and use them again. For example, use margarine tubs for crayons, use the same brown paper lunch bag until it's torn and worn out, or take old clothes to a second-hand shop. Part of the consumer mentality today is "newer is better." This mentality hasn't always existed. When the automobile was first invented, did people buy a new car every 3-4 years? Industrialization via mass production has also enabled us to produce a greater quantity of lower quality products. These products usually are less durable and must be replaced.

### III. Recycle

Recycling is an option for dealing with waste. The benefits, though seemingly obvious, may not be as great as hoped. Recycling is a loop which involves collecting used product materials (such as glass, paper and metal), processing these materials to extract usable raw material, and re-manufacturing the raw materials into new products.

**A. Some of the benefits of recycling may be:**

1. Decreases in the amount of solid waste entering landfills.
2. Reduction in the consumption of virgin natural resources.

**B. The Recycling Loop**

**1. Collection:** Drop-offs, buy-backs, and curbside pickup are all ways that recyclables are collected.

**2. Separation:** Consumers separate their recyclables for collection. When collected, the Materials Recovery Facility separates them again into more specific groups.

**3. Reclamation: a. Chemical or Physical Breakdown:** A used product is melted, scrubbed, purified or processed to obtain near-virgin quality raw material for use in manufacturing a new product.

**b. Bulk Waste Material:** Excess raw material which may be useless to one manufacturer, "waste," may be sold to another manufacturer for a new purpose, eg. petroleum waste sold to plastics manufacturer as raw material.

**4. Marketing:** Finding buyers or a market for the reclaimed material is extremely important to the success of recycling; if there are no buyers, there is no market and no motivation for reclamation. When a market exists and reclaimed material is sold, the recycling loop is completed.

Reclaimed material must be saleable at a price high enough to cover reclamation costs while providing a profit incentive. Likewise, the price must be low enough to attract buyers.

### C. What Can Be Recycled?

Every product has the potential to be recycled, however, the recycling of many products is not energy-, resource-, or cost-efficient. What can be recycled is dependent upon the market.

Recycling programs vary. To see which materials are recyclable in your area, check the local recovery facility, waste pickup or local officials.

The following are some items that are currently being recycled:

| | |
|---|---|
| Glass | Paper |
| Newspaper | Aluminum |
| Steel cans | Rubber Tires |
| Motor Oil | |
| Corrugated Cardboard | |

### D. Problems With Recycling

There are questions about how much energy and resources recycling actually saves. In many cases, the energy invested in recovering resources is much greater than in extracting virgin resources. Also, the energy invested in the entire recycling loop may outweigh the value of the resource recovered.

For example, in recycling a glass bottle, the consumer must first wash out the bottle with water, then transport it to a reclamation or transfer facility. There the bottle is sorted into the correct category and transported to a materials recovery facility where it is physically or chemically broken down into raw material. The raw material is then sold and transported to a purchaser. All of these steps use transportation, transformation, and human energy.

Recycling is an attempt to slow down human consumption of resources to a *sustainable* level. Nature's processes work in cycles, and everything produced and consumed in nature is eventually replaced. Cycles of nature like the water cycle and decomposition cycle are natural recycling systems.

All natural processes have their own speed or pace. Humans, on the other hand, consume natural resources at a much greater rate than nature can produce. Recycling, reducing, reusing, and rethinking help match the human pace with nature's pace.

### IV. Rethink

Each time a product is recycled the quality of the raw material is reduced. For example, paper cannot be endlessly recycled. With each recovery cycle, paper fibers become shorter. Eventually, the fibers will no longer bond together to form paper.

Rethinking helps us become clearer about the complexities of conservation, waste reduction, and recycling. Rethinking helps people create new solutions and make better choices.

## PART II: METHOD

Every day each person generates about 7.1 pounds of trash. Show a bag full of 7.1 pounds of trash.

*What happens to this trash when you throw it in the trash can?* First, it may be picked up by the trash truck. *Then where does it go? Does it just disappear?* No, it probably goes to a transfer station or to the landfill. (Show the picture of a landfill, p.15)

*What happens to the trash at the landfill?* Every day garbage is added to the landfill. At the end of the day it is covered with soil. The problem with these landfills is that they fill up. When a new one has to be built, no one wants it near his or her home.

*If you can't build a new landfill, then what are you going to do with all the trash?* We need to make less trash.

*How can we do this?* By reducing, reusing, recycling, rethinking.

**I. Reduce:** To make less waste; to use fewer resources.

*What are some ways you can reduce?*

**1.** Use both sides of your paper before you throw it away.
**2.** Only use one paper towel when drying your hands, or just shake them dry.
**3.** Ask the students how to reduce in the classroom. Students can: share books, write on chalkboard instead of on paper, share handouts, not use lights when window light is adequate, etc. As a teacher, you can model these simple conservation skills throughout the year.
**4.** Have students think of other ideas.

**II. Reuse:** To use again.

*What are some ways you can reuse?*

**1.** Take your old shopping bags back to the store when you go, or use them for book covers, storage, recycling separation containers, etc.
**2.** Next Christmas, make a gift out of something that's yours but you no longer use?
**3.** Use a lunch box instead of a paper bag or reuse the same paper bag until it is worn out or torn.
**4.** Have students think of other ideas.

**A. Reduce Paper Waste Activity**
(From *Waste Away*, 1989)

**1.** Set up 2 boxes for used paper next to the trash can.
**2.** Label one box "reusable" and the other "non-reusable."
**3.** Collect paper for 1 week, reusing the reusable and adding it to the non-reusable. Explain the difference between what reusable and non-reusable paper is.
**4.** At the end of the week, check to see how much non-reusable paper was generated. Discuss it with the class.

*Did we use less paper by reusing? What can we do with the non-reusable paper?* Recycle it.

**III. RECYCLE:**

To use a product again to make the same product or a new product. The recycling capacity of any material is limited.

**A. Paper Recycling Activity**
(From *Super Saver Investigators*, 1990)

Bring enough newpaper and letter-quality typing paper (preferably used) for each student to have a sheet. Tell the students to lick the corner of the newspaper and then tear it. Do the same with the typing paper. Compare the torn edges noting the length of the paper fibers.

*Which paper has longer fibers?* Typing. *Which paper has shorter fibers?* Newspaper. *Which paper has already been recycled?* Newspaper.

Point out that with each time paper is recycled the fibers break down. Eventually, after 2 or 3 cycles, the paper cannot be recycled and will go to the landfill.

*Can we recycle paper endlessly?*
*Does recycling mean we will never run out of a resource?*

Recycling is an attempt to slow down the human rate of consumption.

**B. Trash Sorting Activity**
Separate students into several groups. Give each group a bag of clean trash obtained from your home or the school. Dump the bags and have the students separate the trash into groups that can be reduced, reused or recycled. Also make a pile that will end up at the landfill.

*Do you think using the 4R's will help our landfills and natural resources last longer and reduce the cost of storing solid waste?*

*Will this help reduce the damage to our environment and the animals that live there?*

*Do humans depend on the environment?*

**C. Homemade Soft Clay Bottle Activity**
(Adapted from *Florida 4Rs Project*, 1990)

To help slow down the human rate of consumption while reducing the amount of waste produced, products can be reused and recycled. For example, glass bottles and jars can be melted down to make new containers and other objects, or returned for a deposit to be cleaned and used again. Paper can be reused to make new paper, packaging, and many other products. Recycled plastic containers are made into new plastic products, or used as fiberfill in jackets. Since plastic has such a low melting temperature and can possibly contain contaminants, plastic bottles are not made into new beverage containers. Metal food cans and beverage cans can be melted down and made into new cans, or used as material for sheet metal.

Soft Clay Recipe: (From *Frog's Book*, 1989)

| | |
|---|---|
| 3 c. flour* | 3 tbsp. oil |
| 6 tsp. cream of tartar | 1 1/2 c. salt |
| 3 c. water | food coloring (optional) |

Mix all ingredients. Cook and stir constantly in a heavy pan on low to medium heat until mixture pulls away from sides of pan. Knead until pliable. Store in air-tight container. Makes 8 cups.

*Do not use self-rising flour.

**Materials:**
soft clay
several glass and plastic bottles
fiber filling from an old jacket or other item made from recycled plastics
1-gallon empty ice cream bucket (or other suitable container) for collection of "used" soft clay bottles

**Procedure:**

1. Show the students the homemade soft clay. Ask them to pretend that this is all of the clay there is in the world. Once they use it up, there will be no more. Tell them they will make bottles with the soft clay and will pretend to drink soda from the bottles. Then the bottles will be thrown away.
2. Give each student a small piece of soft clay and ask them to roll it into a ball. Then tell them to take one finger and push it down in the soft clay to make a hole. Do not go all of the way through the soft clay. Now, have the students pretend to drink from their bottle.
3. Collect their bottles and pretend to "throw them away" in the bucket. Ask them if they want more pretend soda. Repeat this process until all of the soft clay is gone and all of the bottles have been "thrown away."

*Where did all of the clay go?*
*Where did all of the clay bottles go?*
*How are we going to get bottles if there is no more clay to make bottles?*
*What could we do to make the clay last longer?*

4. Discuss the term recycle. Recycling is using the same material to make new products.
5. Tell the students they are going to recycle their bottles. Give each student a piece of the soft clay they have "thrown away" and have them make a new bottle. Tell them this is recycling, making new bottles from used bottles. Show them examples of bottles and cans that are recyclable.

*Why is recycling important?* Recycling can make the soft clay last longer.

6. Tell the students that some materials can be recycled into new things that look different from what they originally were. Show them a plastic soda bottle and some fiber filling that may have been made from a plastic bottle. Tell students some bottles can be returned for a deposit. They can be washed, sanitized, and refilled as many as 7 times before they chip, break or are contaminated beyond use and go to the landfill.

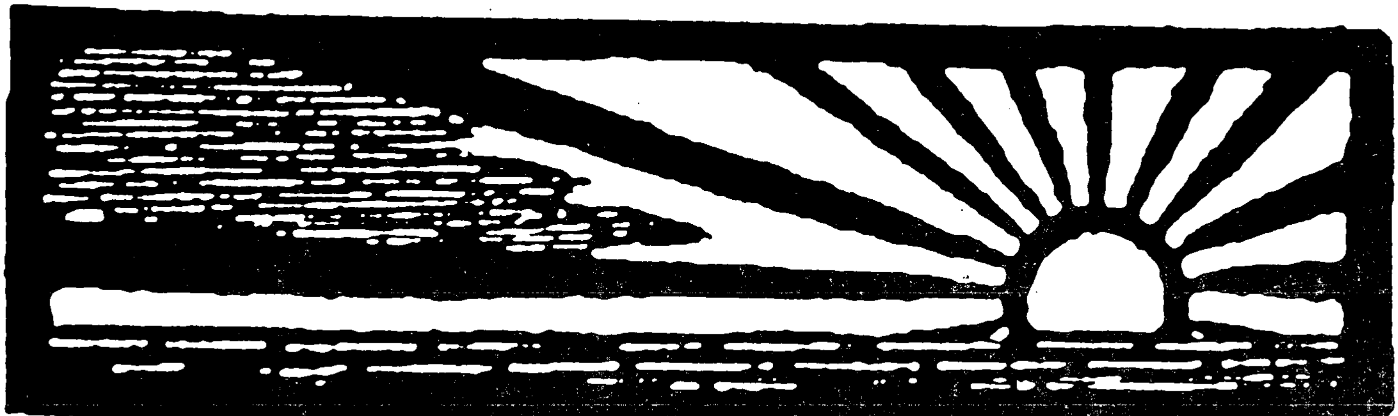
7. Ask your parents to help you set up your own "separation center." Find a dry storage area in the basement, garage, or in a closet. Set up by using cardboard boxes, paper bags, or other containers to hold the separated recyclable items. Color the box or bag and write the name of the item to be placed in it: Plastic, Paper, Aluminum, Glass, etc.

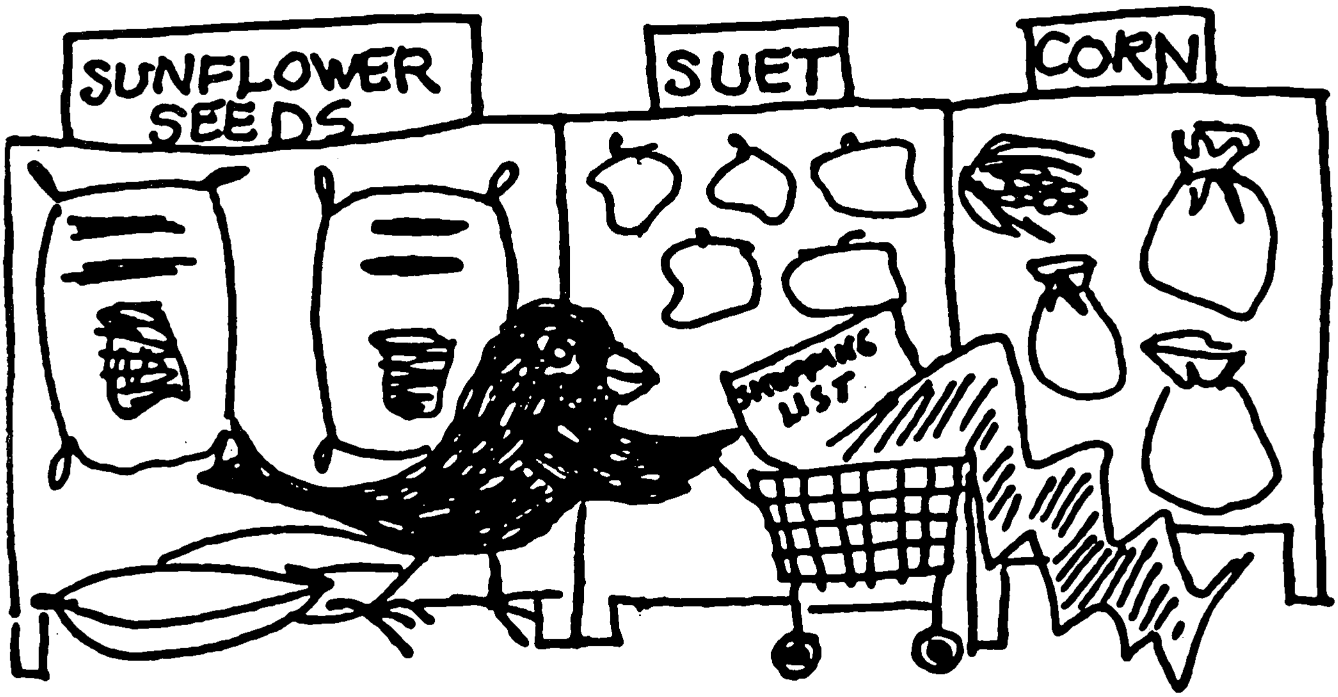
## IV. Rethink

*Is using cloth napkins instead of paper napkins more energy-efficient? Is the water used to wash the napkins a natural resource? Is the sponge a resource? Which uses more energy and resources—the sponge and water, or the paper towel?*

*Which will weigh less and use less gasoline to transport, plastic or glass?* Plastic.
*Which is made from petroleum waste, not from virgin raw materials (sand)?* Plastic.

When factors like these are considered, the benefits of recycling are diminished. Recycling is not necessarily the best solution. *Reduction* is always a better choice.






**Don't forget your 4Rs while grocery shopping.**

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# SECOND GRADE - LESSON 2
# DECOMPOSITION

## OBJECTIVE:

*The students will learn how to reduce the amount of waste going into the landfill by composting organic items.*

## PART I: BACKGROUND

### INTRODUCTION:

Each year Americans throw away 28.6 million tons of yard waste. Combined with food waste, it constitutes 24.6% of landfill waste. Composting organic waste is a form of recycling which reduces landfill wastes.

### I. Decomposition Cycle

Decompostion is the natural process by which microscopic organisms ingest and metabolize organic matter. Through the decomposition process, nutrients are made available to plants. In turn, the plants provide energy for living animals.

Composting is the controlled biological degradation of organic matter to produce humus. When a compost pile is created, the natural process of decomposition occurs. Bacteria and fungi feed on organic material -- dead plants and animals. In metabolizing the organic wastes, the microbes grow, reproduce and produce heat. Decomposers are found everywhere but are most plentiful in the soil.

The end product of composting is humus, a dark, earthy-smelling, crumbly material that is a natural fertilizer. Decomposition returns organic wastes to the earth, recycling them for use by other forms of life. When humans set up composting piles, they facilitate the natural decomposition process.

### II. Affecting Variables

**A. Moisture:** Moisture is necessary for bacteria and fungi life. Rain water is best because it carries oxygen, minerals, and microorganisms. Too much water will cause the compost to putrify.

**B. Oxygen:** Aerobic bacteria need oxygen to survive. Turning the pile increases oxygen. The increased activity of the bacteria in turn increases the heat.

**C. Nutrients:** Nutrient content of the compost is determined by the type of organic material in it. For example, grass is high in nitrogen and breaks down easily. Other materials are high in phosphorous and potassium. These also speed the decompositon process.

**D. Temperature:** Since the microbes produce heat as they metabolize the organic material, temperatures naturally rise. Increased temperatures not only speed the decomposition process, but also destroy pathogens.

## PART II: METHOD

Show examples of organic waste (banana peel, grass clippings, leaves, twigs, hay, egg shells, orange peels, etc.).

*How do you usually dispose of organic waste?* If the suggestion of putting these items in a trash can is made, ask where they think it goes after the trash truck takes it. When organic items are thrown away they end up at the sanitary landfill. At the landfill, waste is deposited daily. At the end of each day, the waste is covered with soil.

*What happens to the landfill over a period of time?* It fills up. Then a new landfill must be built. But nobody wants a landfill near their house.

*So, what do you think we can do to make our landfills last longer?* Compost. Each year Americans throw away 28.6 million tons of yard waste.

### I. Decomposition Activity

(From *Super Saver Investigators,* 1990)

Decompositon is nature's own recycling process. Plants use the sun's energy to grow. Some plants become food for animals and some plants die. The plants that die decompose into nutrients which enrich the soil. For example, every autumn when leaves fall off trees, they decompose making the soil rich in nutrients so that the tree can grow leaves in the spring.

1. Write the following items on the board:
   --leaves on the ground are eaten by decomposers
   --leaves die and fall to the ground
   --tree uses nutrients from the soil to grow new leaves
   --nutrients from the leaves are returned to the soil
2. Ask students to rank each in the order it occurs.

### II. Decay Machine Activity

(From *Waste Away*, 1989)

**Materials:**

decay machine
small containers
compost humus
crushed bottle
tablecloth
kitchen scrap
plastic bottle

**Optional items:** glass jars, styrofoam, aluminum cans, plastic bags, etc.

**Procedure:**

The decay machine can be made from a large cardboard box with closable front and back flaps. A movable arrow should be attached to the clock that has the seasons. (Fig. 1) Have the children color the box for fun.

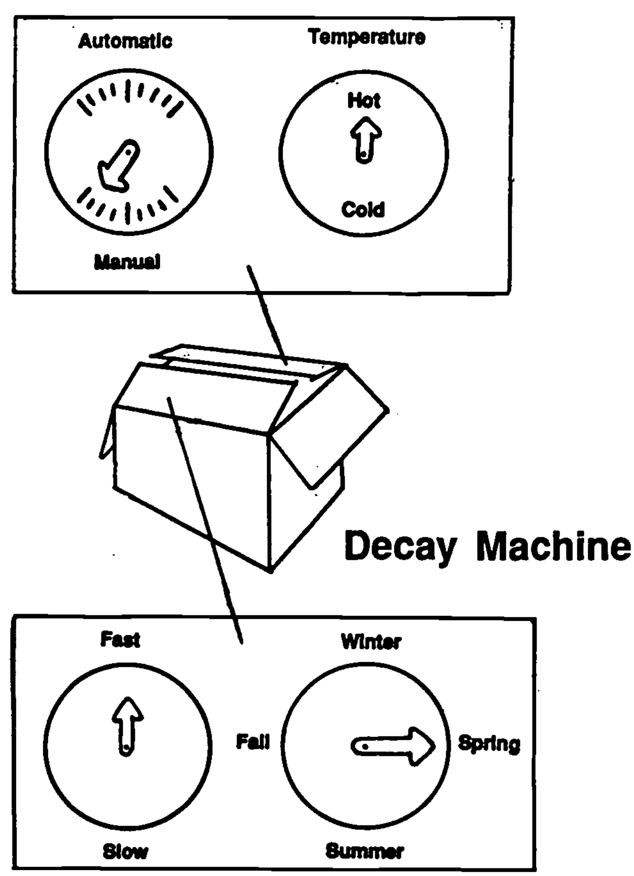


Fig. 1

13

**Set-Up:**
Place the decay machine on a table and place the small containers of decomposed material on the table behind the machine. If an assisstant is available, have examples of the decayed material under the table with a cloth draped over to hide them. The assistant can open the back flaps and substitute the materials when needed.

**1.** Explain that with the help of a decay machine you will show what happens to food waste over a period of time. Open the front flap of the decay machine and place inside of it a small dish of leaves, then close the machine.
**2.** Move the dial from spring to summer, representing the passage of one season. Explain that several months have passed. Pull out the containers of decomposed leaves. Show the students what is happening. Repeat for a second season, this time displaying a dish of humus.
**3.** Also try part of an old log, vegetable matter, etc. Discuss composting and explain how it is another solution to the waste problem.
**4.** Now show the children a plastic bottle and place it in the decay machine. This time turn the dial so that several years go by. Remove a crushed bottle similar to the original one. Show the students what has happened. Discuss the fact that plastic is nondegradable.
**5.** List several items that are biodegradable and can be used in a composter (vegetable scraps, wood, grass) as well as several nondegradable

items (rubber tire, plastic bag, can).

**III. Model Composter**
(From Bottle Biology Resources Network, 1991)

**Materials:**

| | |
|---|---|
| leaves | newspapers |
| grass clippings | spray bottle |
| hot tap water | knife |
| scissors | hole punch |
| clear tape | nylon mesh |
| rubber bands | |

two 2-liter plastic soda bottles
vegetable or fruit scraps cut into small pieces

**Procedure:**
**1.** Remove labels from bottles by pouring hot tap water over the label.
**2.** Draw cutting lines around the bottle using a felt tip pen or place a rubber band around the bottle as a guideline. (Fig. 2 ) Plan carefully before cutting. The bottle shape and location of the cuts affect how the bottles fit together. When in doubt, cut bottle pieces long; you can always shorten them.
**3.** Make an incision using the tip of scissors and have students finish the cut by following the lines or rubber band.
**4.** Attach a small piece of nylon, or mesh fabric, to the top of the bottle using a rubber band. This will permit drainage.
**5.** For ventilation poke air holes into the sides of the plastic using a hole punch or scissors.
**6.** Add ingredients for composting through the top of the compost column.
**7.** Water your compost using a spray bottle.
**8.** Using a stick, carefully stir your compost mixture twice a week.
**9.** Observe and record weekly changes in compost.
**10.** Use the end product to enrich the soil in a garden or around the plants at school.

# 2-Liter Compost

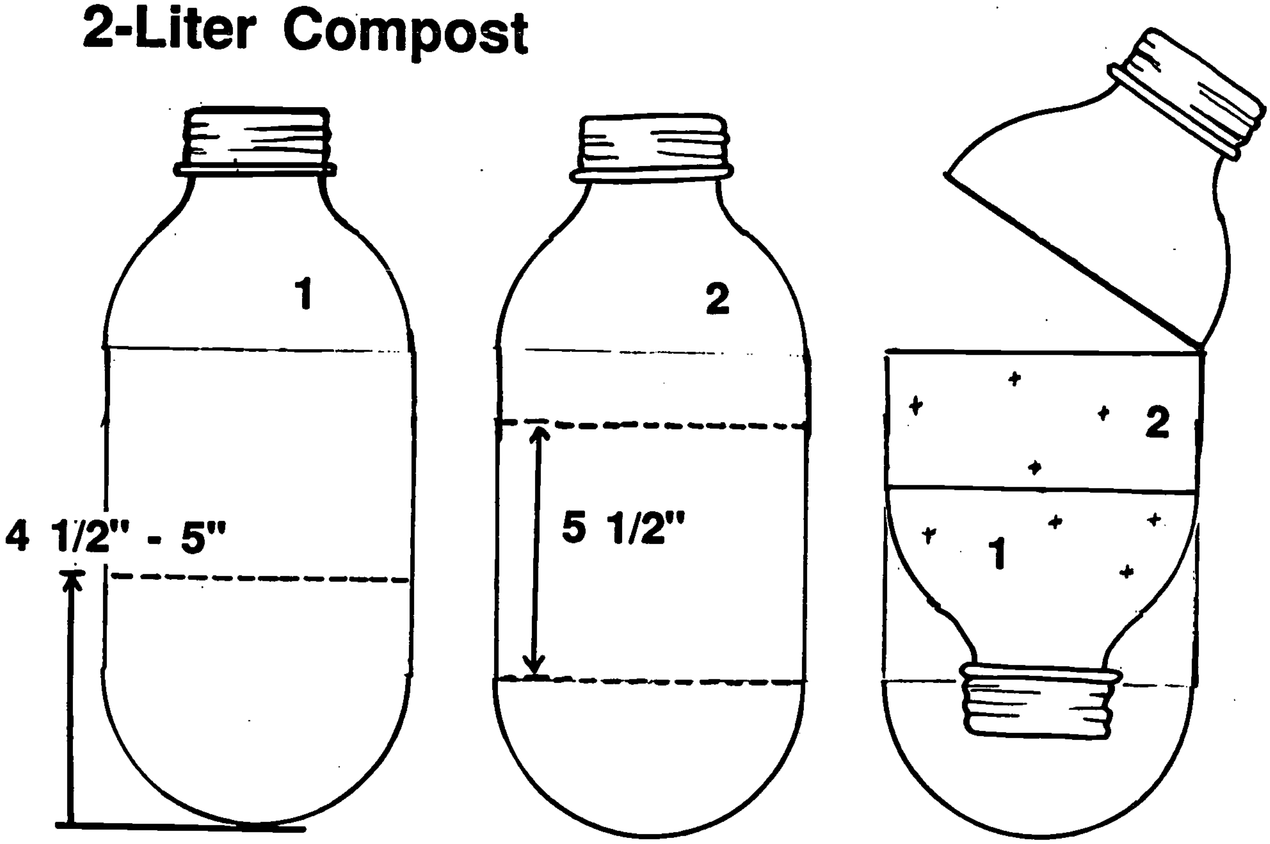


Fig.2

**The spare parts of your 2-liter bottles can be used for a variety of things before they are recycled. For example, bases can be made into bird feeders or knick-knack holders; the top portions can be used as funnels, etc.*

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# THIRD GRADE - LESSON 3
# LANDFILLS

## OBJECTIVE:

*The students will learn how a sanitary landfill is constructed, what happens to their trash when it arrives at the landfill, and what they can do to reduce the amount of trash going into the landfills.*

## PART I: BACKGROUND

### INTRODUCTION:

Each day every person throws away approximately 7.1 pounds of trash. In Ohio, "away" is to one of the EPA-regulated landfills. Sanitary landfills are controlled land disposal sites for solid, non-hazardous waste. Here, wastes are spread and compacted in layers a few feet thick. At least once a day the waste is covered with a layer of soil and then compacted again. Modern sanitary landfills are designed to protect the environment by containing and isolating waste.

### I. Landfill Regulations

In 1990 the Resource Conservation Recovery Act was reauthorized. Subtitle D required that all sanitary landfills be equipped with the following: (1) recompacted clay liner to contain rainwater and liquid wastes; (2) drainage/leachate system to prevent groundwater contamination; (3) methane system to reduce combustion hazard; (4) cells to hold waste; (5) monitoring systems; and (6) leach ponds to hold runoff. As a result, many of the sanitary landfills built within the last three years are better engineered than those built four or more years ago.

Landfills are both federally and locally regulated. Monitoring is the primary means of regulation. In 1986 the average annual monitoring cost for a landfill ranged from $8,000 to $40,000 per year, depending on the site.

### II. Transfer Stations

Some of our waste in Ohio may pass through a transfer station before it reaches the landfill. In a transfer station, wastes are brought to a regional center to be processed by shredding or compacting. In some cases, transfer stations may include separation or composting facilities. After the waste is processed, it is put on a truck for transport to a landfill.

### III. Incinerators

Combustion facilities reduce the volume of trash, but they also produce waste. The ash left after burning is landfilled or used in products such as roadsurfacing materials. Added Water used in ash quenching is a waste product of combustion. Incinerators also contribute to air pollution.

The Solar Energy Research Institute has created a technique called *sun burning*. A furnace of mirrors multiplies the sun's heat 21,000 times. Garbage burns and the ultraviolet light destroys the air pollutants.

Some combustion facilities can produce energy in the form of steam or electricity. Building a reliable market and maintaining a consistent waste stream will determine the success of these waste-to-energy facilities in the future.

### IV. Pollution Problems with Landfills

**A. Water:** The liquid that results from rain, snow, dew, and natural moisture percolating through waste is called *leachate*. It carries dissolved or suspended materials that may contain toxic chemicals, heavy metals or organic components. These can contaminate ground water, surface water and soil. Before the advent of the sanitary landfill, organic strength of leachate obtained from dumps reached levels greater than 20-100 times the strength of raw sewage.

**B. Methane Gas:** As waste anaerobically decomposes, it produces an acrid smelling gas called *methane*. Methane tends to accumulate in closed areas. Since the gas is highly combustible, it is a threat to human safety. New landfills are required to have equipment to collect the methane gas. It can be burned at the surface or refined and used as a commercial fuel. Methane begins forming two years after closing a cell. High concentrations are produced for 10 to 20 years and lower concentrations continue to be formed for up to 100 years.

## PART II: METHOD

Show a bag filled with 7.1 pounds of trash.

*Where does the trash go?* Use the picture of a landfill to discuss how the sanitary landfill is built and how it operates. Have students identify the parts of a landfill on their copy of the landfill.

*What happens to the trash buried in a landfill? Does it decompose?* Biodegradable items in a landfill take longer to decompose than they do in nature because of the lack of oxygen, water, and sunlight.

*What do you think happens to the landfill over a period of time?* It fills up. *Then what has to be done?* A new landfill must be built. Most people do not want a landfill near their home. This attitude is called NIMBY (Not In My Backyard).
*If no one wants a landfill near their home, then what are we going to do with the trash? What can we do to make our landfills last longer?* We will probably always need to use landfills, but we can make them last longer by reducing or making *less* trash.

### I. Making a Model Landfill
(Adapted from *Think Earth*, 1990)

**Materials:**
2 - #10 tin cans with 8 - 1/8 in. holes in bottom
2 pie pans
soil to fill each can halfway
3 feet of plastic aquarium hose
1 rubber band
small piece of nylon stocking
small pieces of home-generated garbage
modeling clay or homemade soft clay (p.4)
colored crepe paper
paper/pencil to make a list of items in landfill
spray bottle filled with water

*What happens to your trash after you throw it away?* It gets picked up by a garbage truck and eventually ends up in a landfill.

*Has anyone ever been to a landfill?* Most trash in Ohio ends up in landfills.

*What happens to trash once it is buried in a landfill?* Discuss some of their answers.

**Procedure:**
**1.** Then ask them to help you build two model landfills: an old-fashioned dump and a sanitary landfill.
**2.** Line one tin can with flattened modeling clay or homemade soft clay and a piece of plastic. Pat out clay into a thin layer, like a pie crust, and cover it with the plastic. This represents the liner of a sanitary landfill.
**3.** Do not line the second tin can. It represents an old-fashioned dump. Dumps were made by digging a hole, filling it with trash, and covering it with dirt.

**4.** Attach a piece of nylon stocking over one end of the plastic aquarium hose with a rubber band. Put this end in the bottom of the lined landfill. This will be your monitoring well for leachate. The leachate that collects at the bottom can be siphoned off and examined.
**5.** Have students cut the different garbage items into small pieces. You will have to cut or break metal, glass, or leather items.
**6.** Place the trash and soil into the tin cans, alternating layers until they are half-filled. Make a list of all items placed in each "landfill" or keep an example of each piece of trash. To represent toxic waste, use crepe paper (the color leaches out).
**7.** Place a pan under each tin can to collect seepage or leachate.
**8.** Have students water or "rain on" each landfill twice weekly and observe the changes that are taking place. Be sure to use the same amount of water in the sanitary landfill and the old-fashioned dump. Pay close attention to the seepage or leachate accumulation in each pan. The seepage from the unlined landfill can be observed as it collects in the bottom of the pan. This observation helps to show children how groundwater can be contaminated. The lined landfill should not have any seepage.
**9.** *Where did the rain water go in this landfill?* To find out, siphon leachate out of the bottom of the clay-lined tin can. As the leachate is drawn up the hose, stop siphoning and put this end of the hose into the pan or a glass jar. This should draw off all of the leachate. Observe the leachate and discuss what you have found. *Did any toxics show up?* In modern landfills, leachates are collected and disposed of to prevent groundwater contamination.
**10.** After several months, open each landfill and see how many items you can still identify.

*What would have happened to the leachate if it was not siphoned off or trapped in the pan?*

## II. Additional Activities:

### A. Make a Trash Pizza

(Adapted from *Think Earth*, 1990)

Use a pizza box. Cut out a very large circle of cardboard and mark the sections as follows:

| | |
|---|---|
| Paper 37.5% | Yard Wastes 17.9% |
| Metals 6.9% | Glass 6.7% |
| Plastics 8.3% | Food 6.7% |
| Other 14.6% | Aluminum 1.4% |

Glue appropriate non-biodegradable items to the trash pizza.(Fig.3)

Alternative Suggestion: Make an edible pizza with pepperoni = paper, ham = metals, green peppers = plastics, mushrooms = yard waste, onions = glass, sausage = food scraps, pineapple = aluminum, and cheese = other.

**TRASH PIZZA**

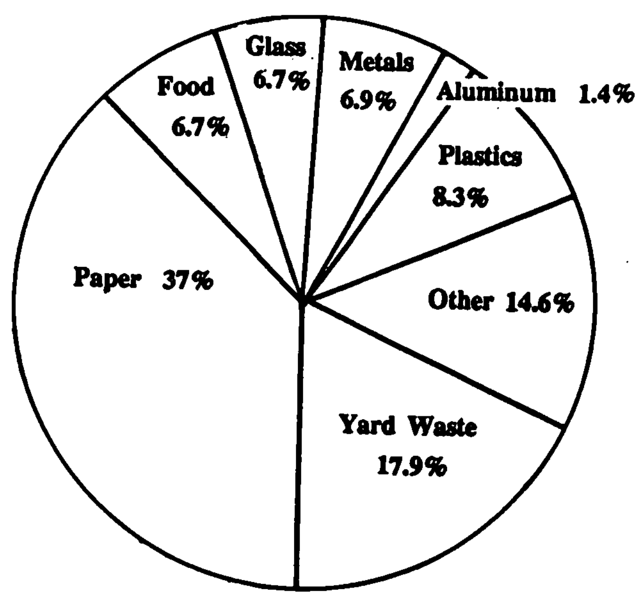



Fig. 3

### B. Bag of Trash

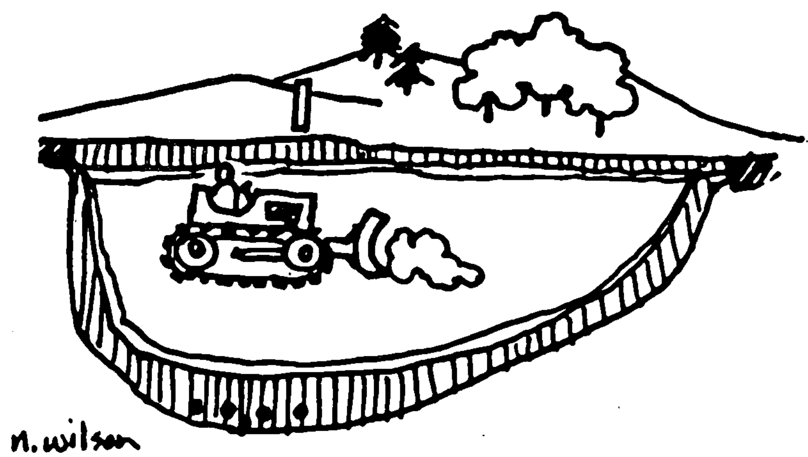
Make a 4 pound bag of trash from trash items we throw away each day. Have students guess what might be in the trash bag. *Can you imagine how much trash we would have in our room if all of us brought this much trash in every day?*

Think about how much trash is thrown away in our town, state, or country.

Divide the class into several groups. Each group gets a bag filled with a variety of trash items, such as cereal boxes, a glass bottle, a T-shirt, rags, magazines, etc. Have each student take an item out of the bag and determine its resource base and whether it can be reduced, reused, and/or recycled.

**C. Classroom Trash**
Save the trash in your classroom for several days. Weigh the trash. Figure out how the class can make less trash by using the 4Rs. Find out where your school trash goes. How much does it cost the school? Set up a separation center in your school. Find out what can be recycled in your area. How will the recycled material be collected? How will it be picked up?

**D. Plan a Field Trip to a Local Landfill**

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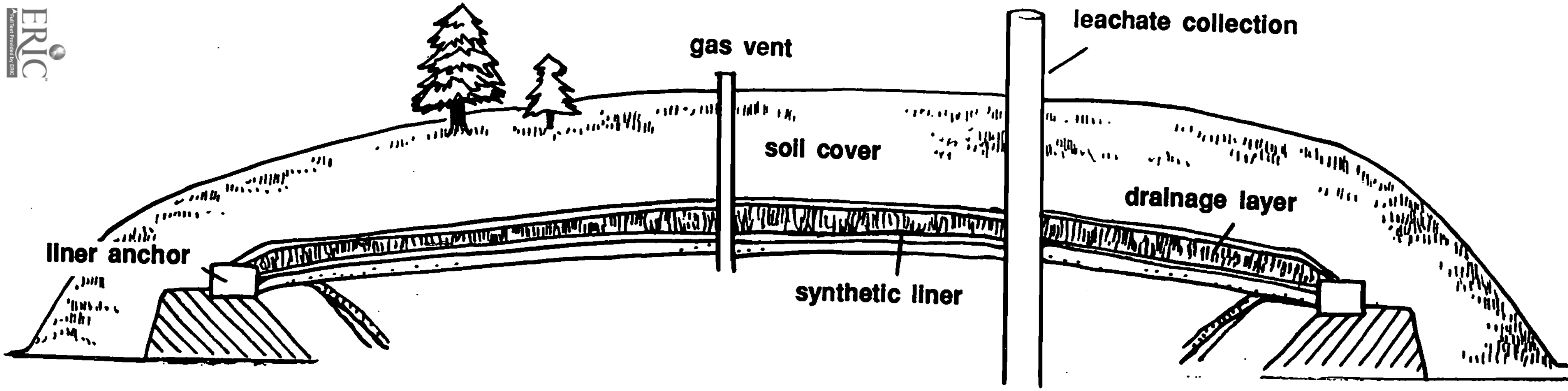
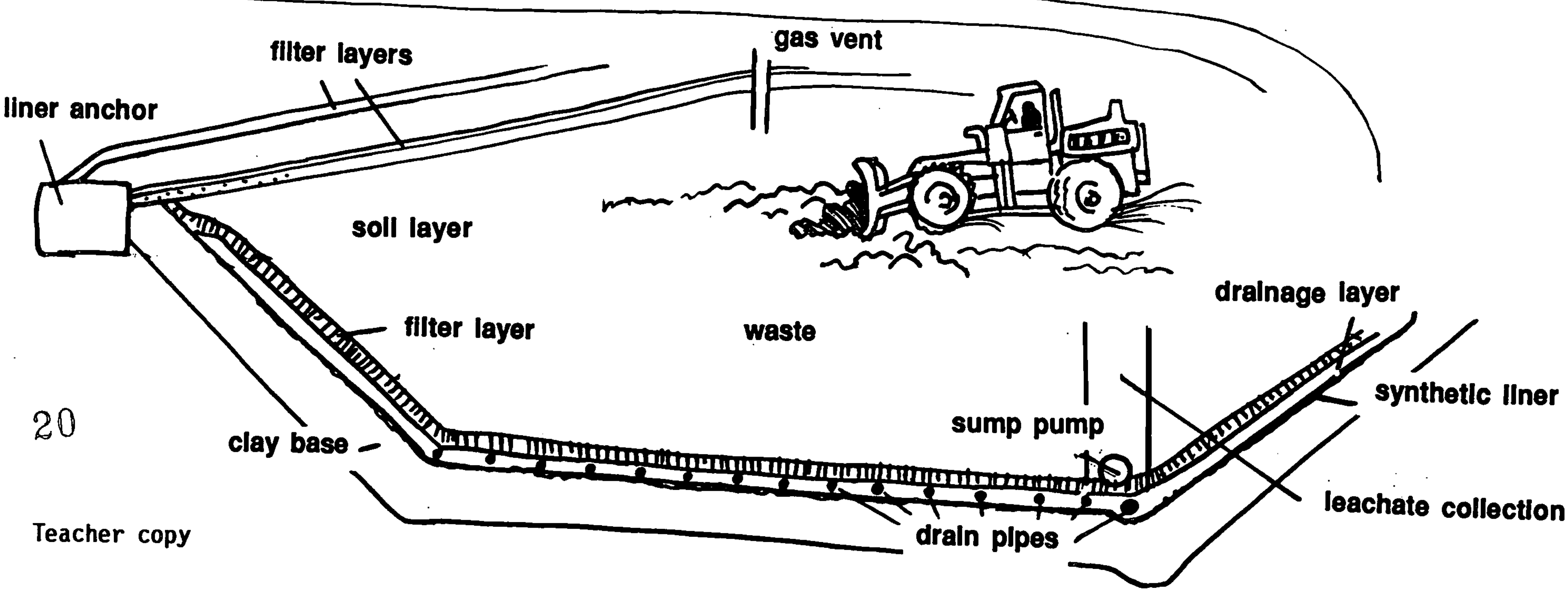
# Modern Solid Waste Landfill





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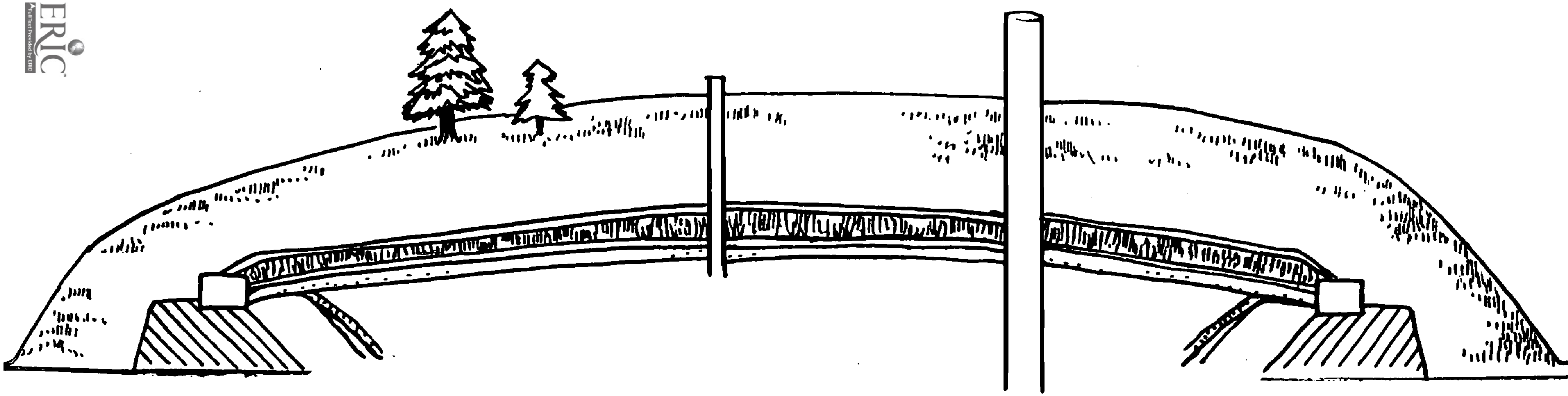
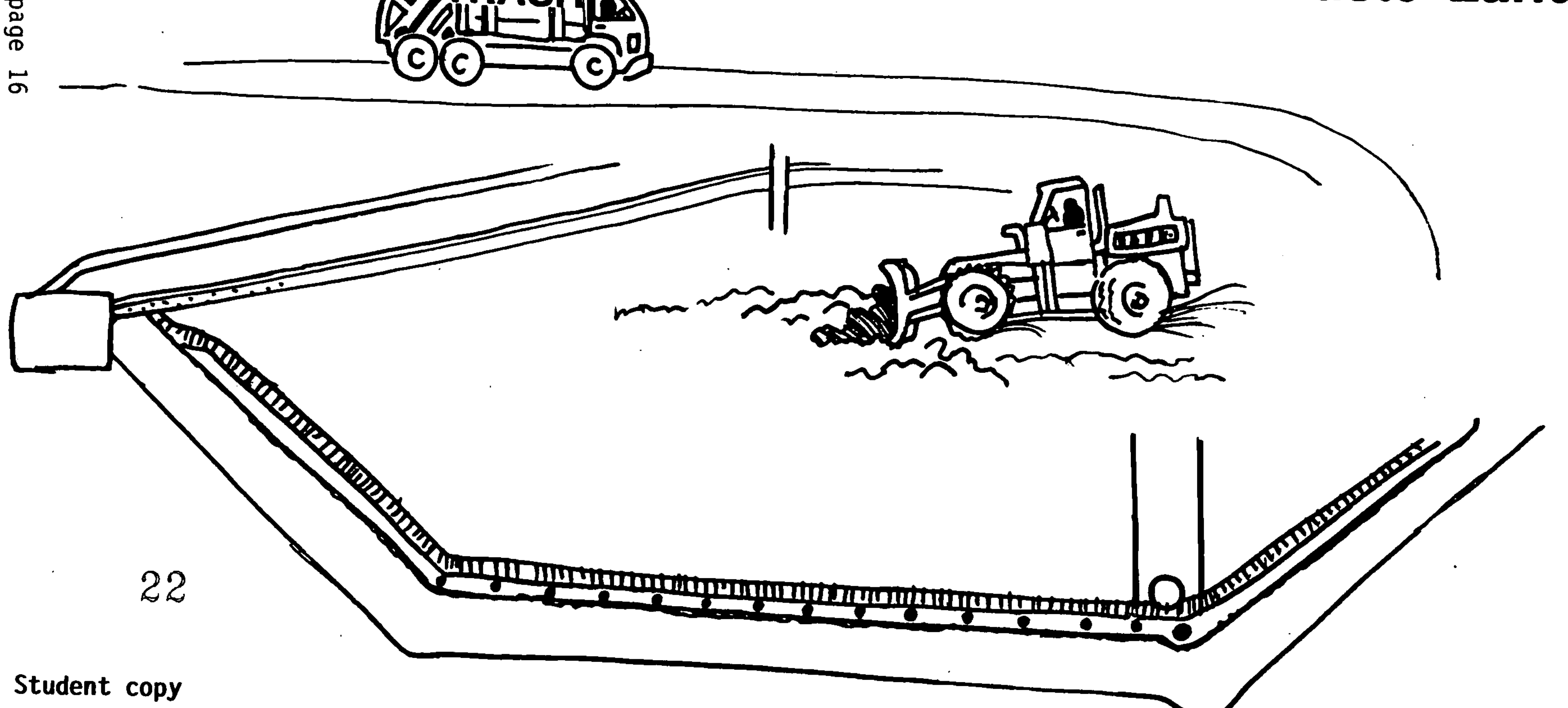


# Modern Solid Waste Landfill



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# FOURTH GRADE - LESSON 4
# NATURAL RESOURCES

## OBJECTIVE:

*The student will develop an awareness of the natural origins of a variety of products.*

## PART I: BACKGROUND

### INTRODUCTION:

Humans, like all living things, use natural resources from the environment in order to live. However, humans are different than other animals. A 1990 NAAEE (North American Association for Environmental Education) report stated that the United States' 250 million people had a much higher per capita consumption of resources than India's 800 million residents. The United States, with only 6 percent of the world's population, consumes 40 to 50 percent of the world's depletable natural resources.

Population growth has a direct impact on resource consumption. As per capita consumption increases, the earth's population carrying capacity decreases.

### I. Natural Resources

Natural resources are naturally occurring materials such as coal, soil, wood, water and minerals, that are products of natural processes.

**A. Renewable Resources:** Renewable resources are natural resources that replenish in relatively short time spans (i.e. sun, wind, water, wood, fish). With careful planning and management, the human consumption rate approximates the production rate. Ideally, this type of development is *sustainable*. Sustainable development of the earth's resources provides consistently for the needs of both the present and future generations.

Although, renewable resources have the capacity to replenish, the rate is not always compatible with human consumption. For example, large-scale timber harvesting doesn't permit complete regrowth of trees. This leads to depletion of mature forests valued for different resources than the younger forests that are replacing them.

**B. Depletable Resources:** Depletable Resources are natural resources that either are scarce, or take great lengths of time to form (i.e. coal, oil, natural gas, minerals). When rapid human consumption outpaces the natural production rate, resources are depleted. We often think of these resources as finite, or in limited supply.

### II. Waste Resources

Through our everyday production, distribution and consumption of products, many resources are used and thrown away. Each day, tons of valuable natural resources are buried in our landfills as "waste."

For example, appliances we use in our homes, like stoves, cooking pans and silverware, are made from metal ore. The paper we use and throw away comes from trees; plastics and synthetic fabrics are made from petroleum products. When we throw away an old, scratched up pan, it gets buried at the landfill. Thus, the metal ore resource gets buried in an unnatural, processed state.

Viewing wastes as resources can help us to see their value. Waste is a resource *thought* to have little or no value. Value is largely determined by the economics of supply and demand.

### III. Processing

Extraction, purification and refinement technologies increase the economic value of natural resources, but they also degrade the environment.

## PART II: METHOD

Show a bag filled with approximately 7.1 pounds of trash. This represents how much trash each one of us makes each day. Pull out several types of trash from the bag: an aluminum can, glass bottle, plastic jug, T-shirt, scrap wood, and a leather belt, for example.

### I. Identifying Resources

All of these examples of trash come from the earth. Look at this soda can.

*What is this soda can made of?*
*What was it before it became a soda can?*

Do for each item:
*What is this ---- made of?*
*What was it before it became a ---?*
*Where does that come from?*

*Can you think of anything you use that is not made from a natural resource?* The students will name some abstract items. Explain what resources went into making the item. For example, a watch has a glass face, leather strap, and metal parts. Sand, leather and metal are the natural resources used to make them.

### II. Matching Game

Show the students the natural resource picture cards (pg.20-26) and have them identify each one.

**1.** Have students close their eyes. Tap two students on the head. Have them open their eyes and come to the front of the room, where together they are to choose a natural resource picture card and a piece of trash made from that resource. They then show the class the natural resource picture card and trash item.
**2.** Instruct the remaining students to name the resource card chosen and to identify the trash item made from it. Repeat this process until everyone has had a turn. Introduce the students to two terms, "renewable resources" and "depletable resources."

*Which of the natural resources used in the matching game are renewable?* Water, air, sunlight, plants.

*Which ones are depletable?* Metal ores and fossil fuels.

### III. Homemade Soft Clay Resources Activity

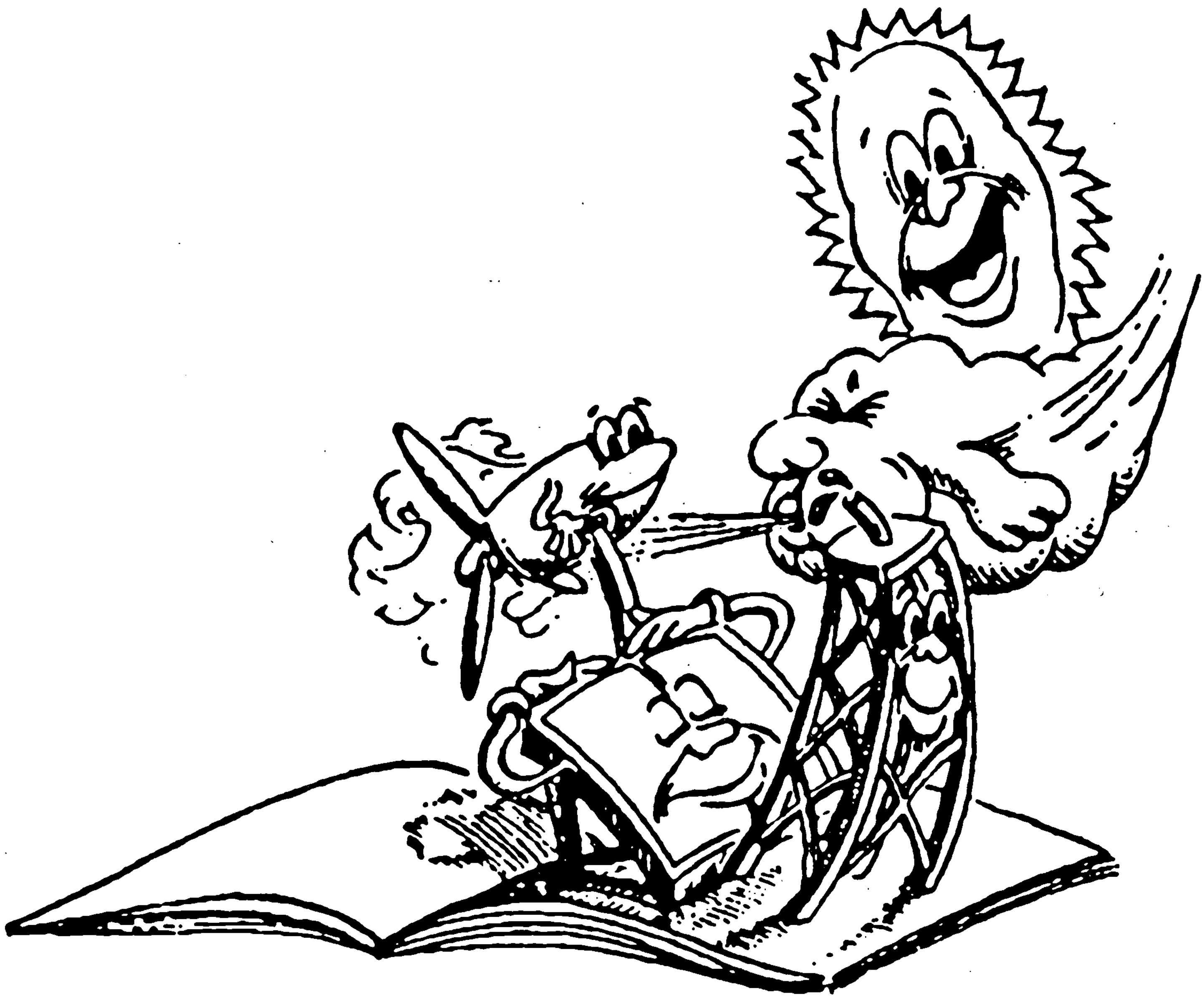
(Adapted from *Florida 4Rs Program*, 1990)

**For homeade soft clay recipe and procedures see Lesson 1 - The 4Rs - page 4.

**1.** Have students sit in a circle on the floor.
**2.** Pass out some of the soft clay from a container labeled "earth". Explain that the soft clay represents the earth's natural resources.
**3.** Break students into groups of 2 or 3 and instruct them to make models of toys, clothes and appliances they use.
**4.** When they are finished, have them tell the members of their group what they've made.
**5.** Join in a circle. Moving around the circle, ask each student to identify his/her model.

For each model item: Ask *what natural resource is ---- made of?* Over time, the quantity of natural resources available diminishes because humans use them up, just like we used up the soft clay.

*What else can we do with things instead of throwing them away?* Reduce, reuse, recycle, rethink (see *Lesson 1* for further information on this topic.)



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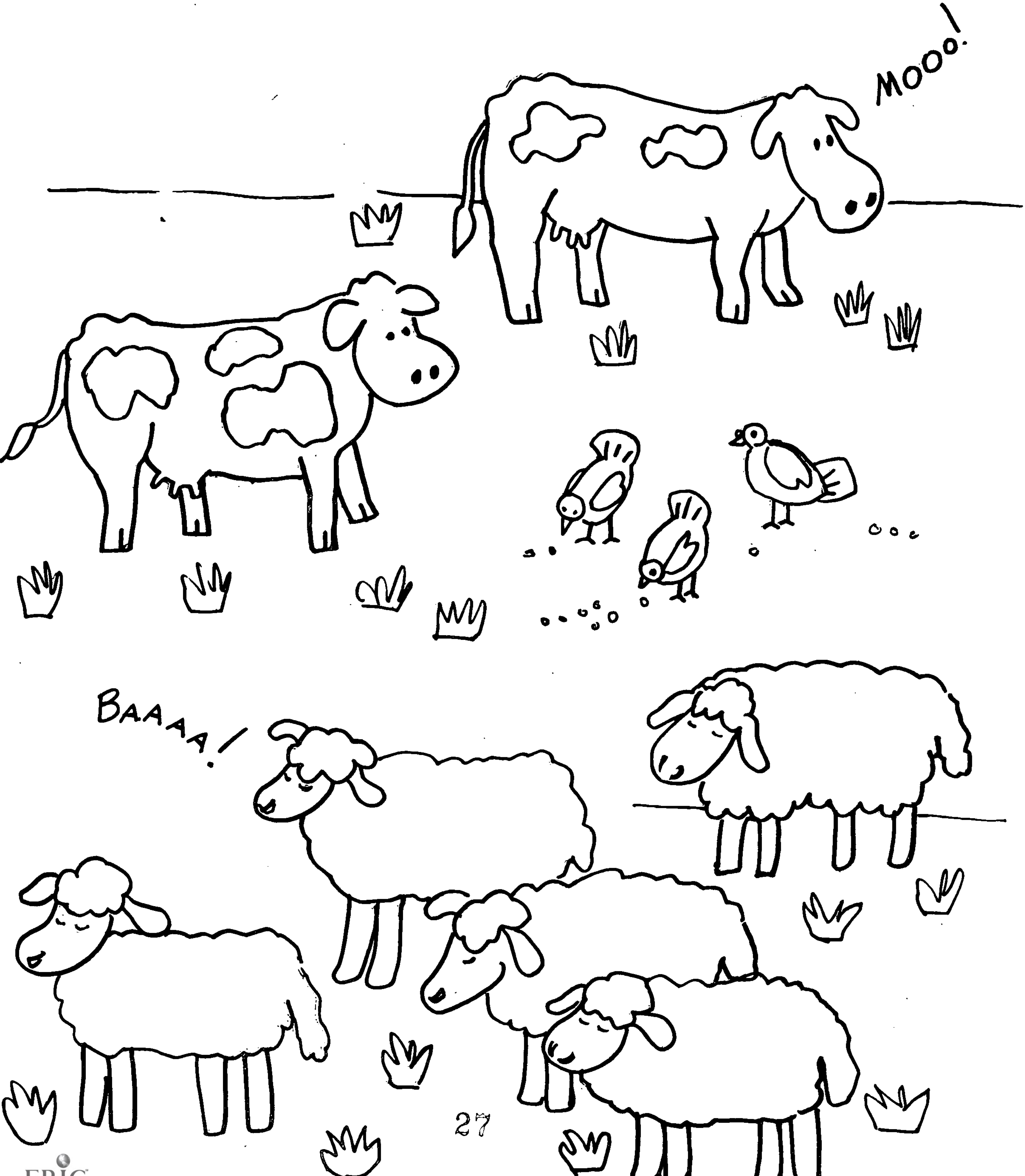
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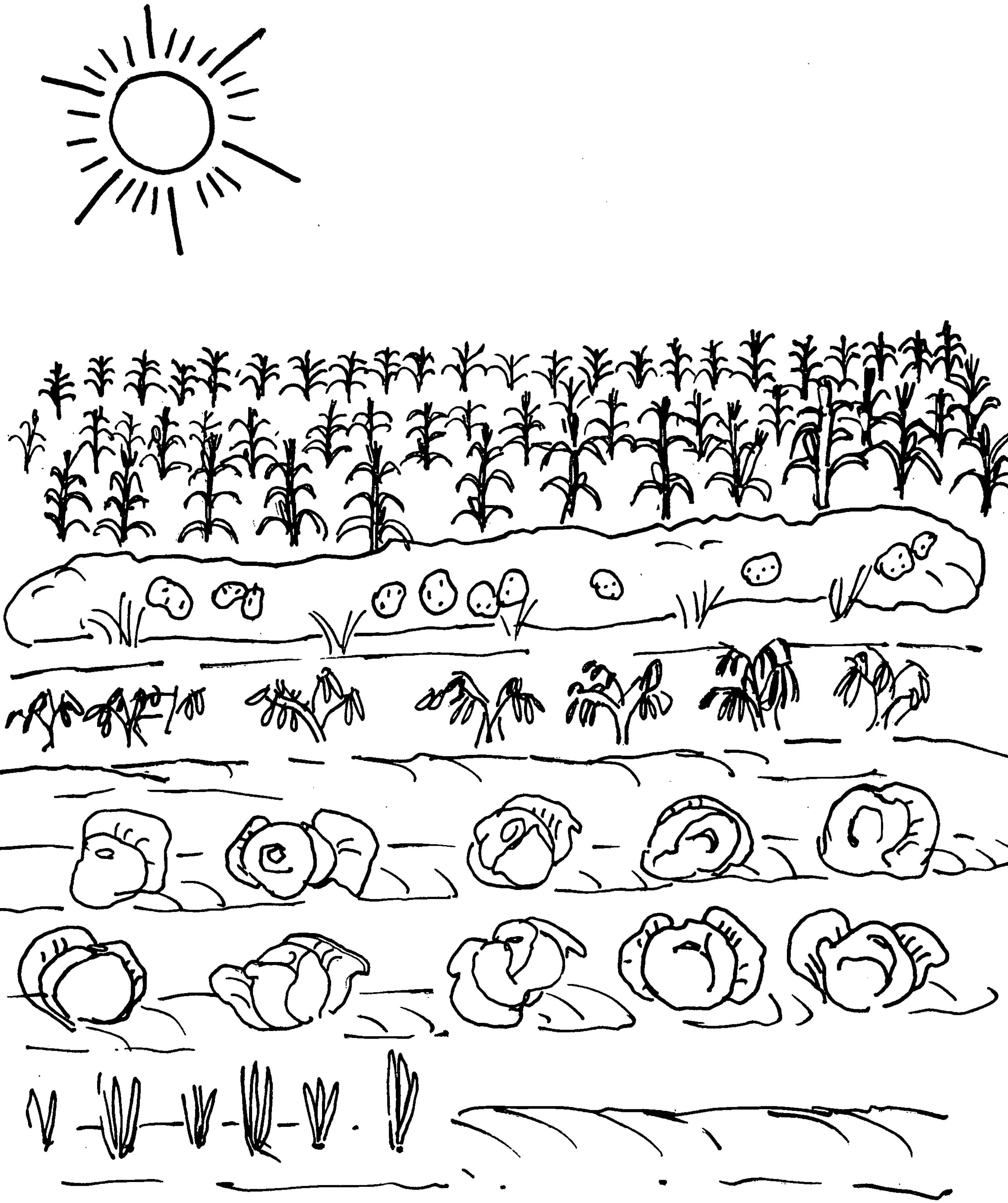

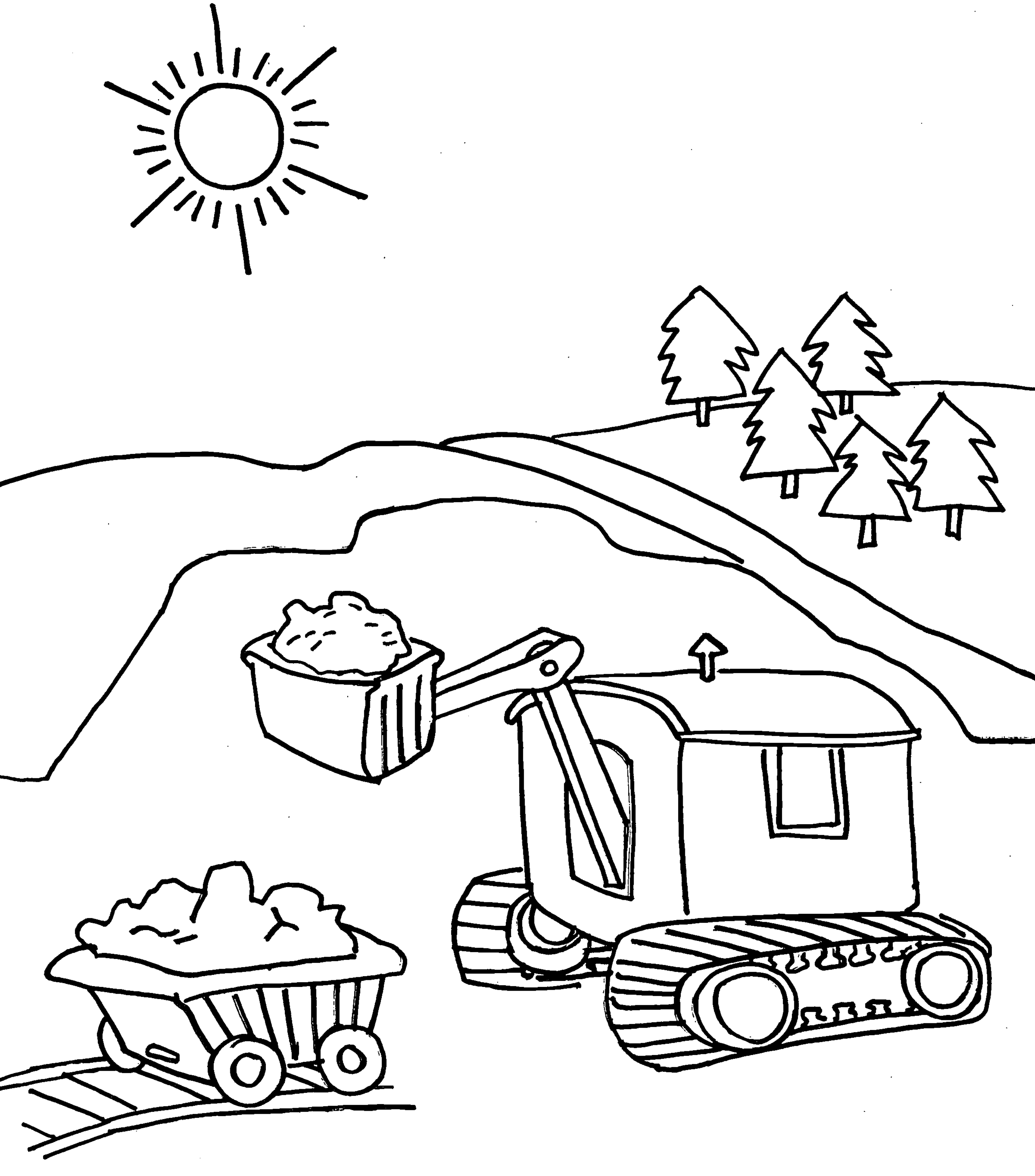

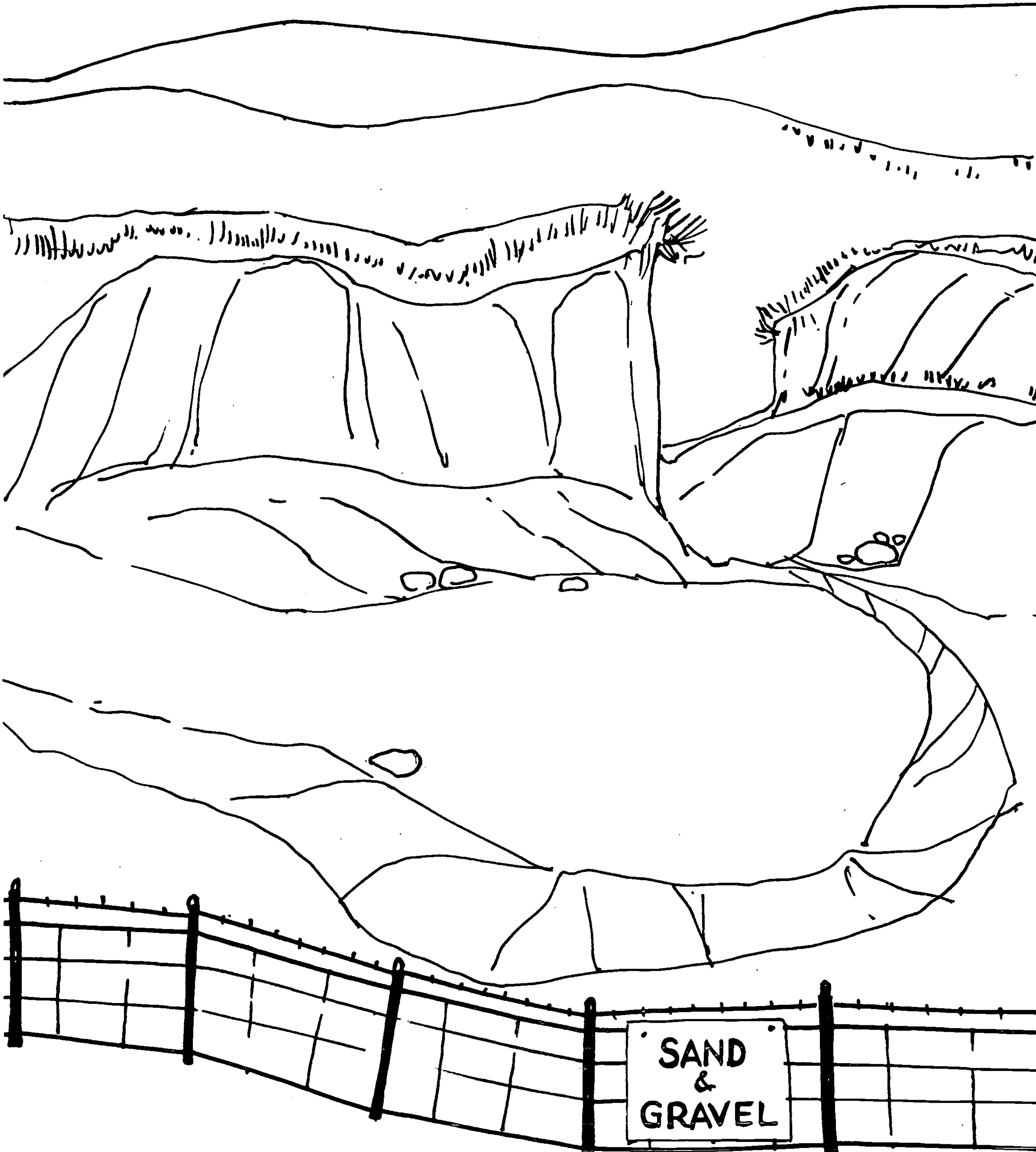
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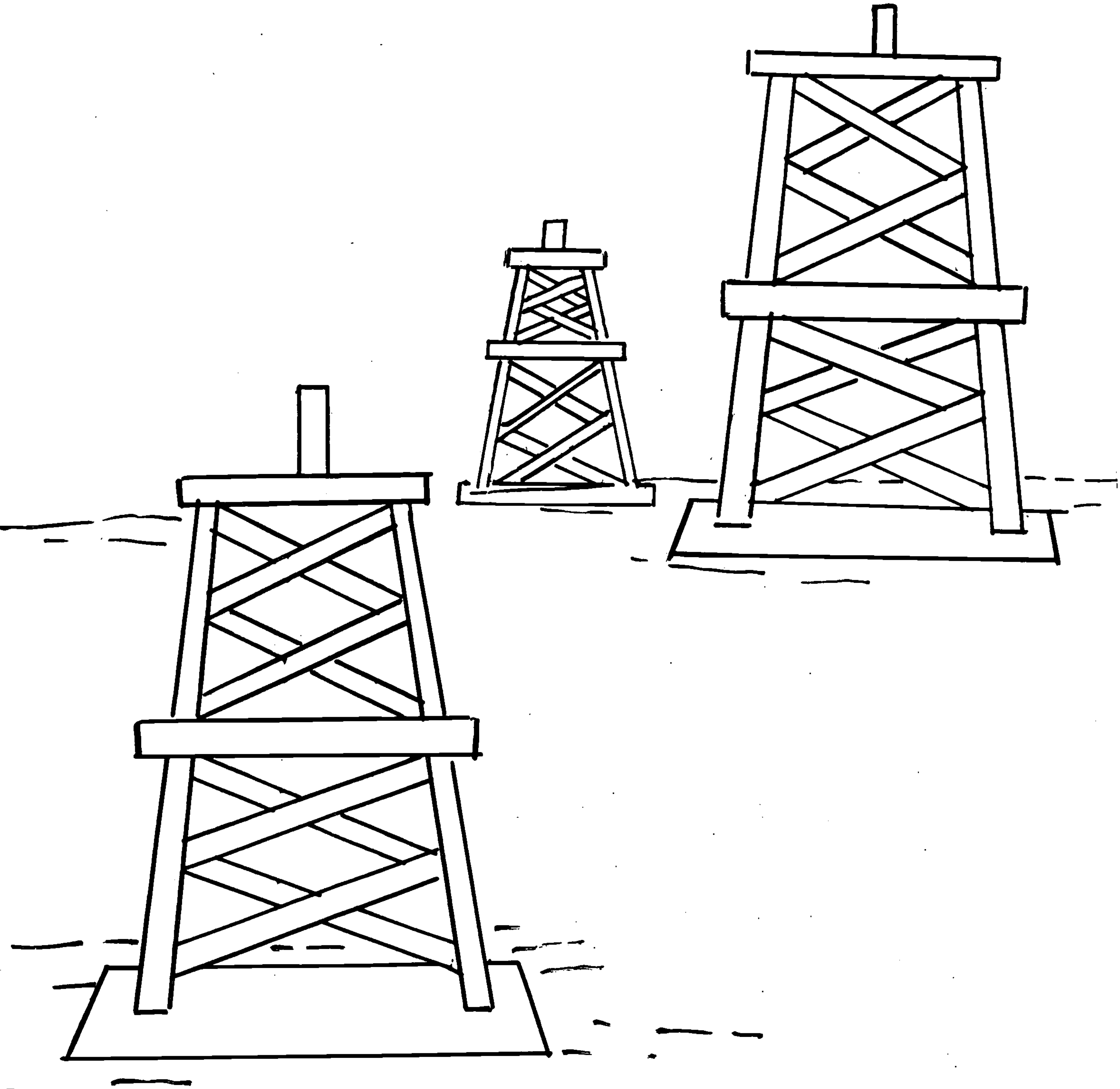
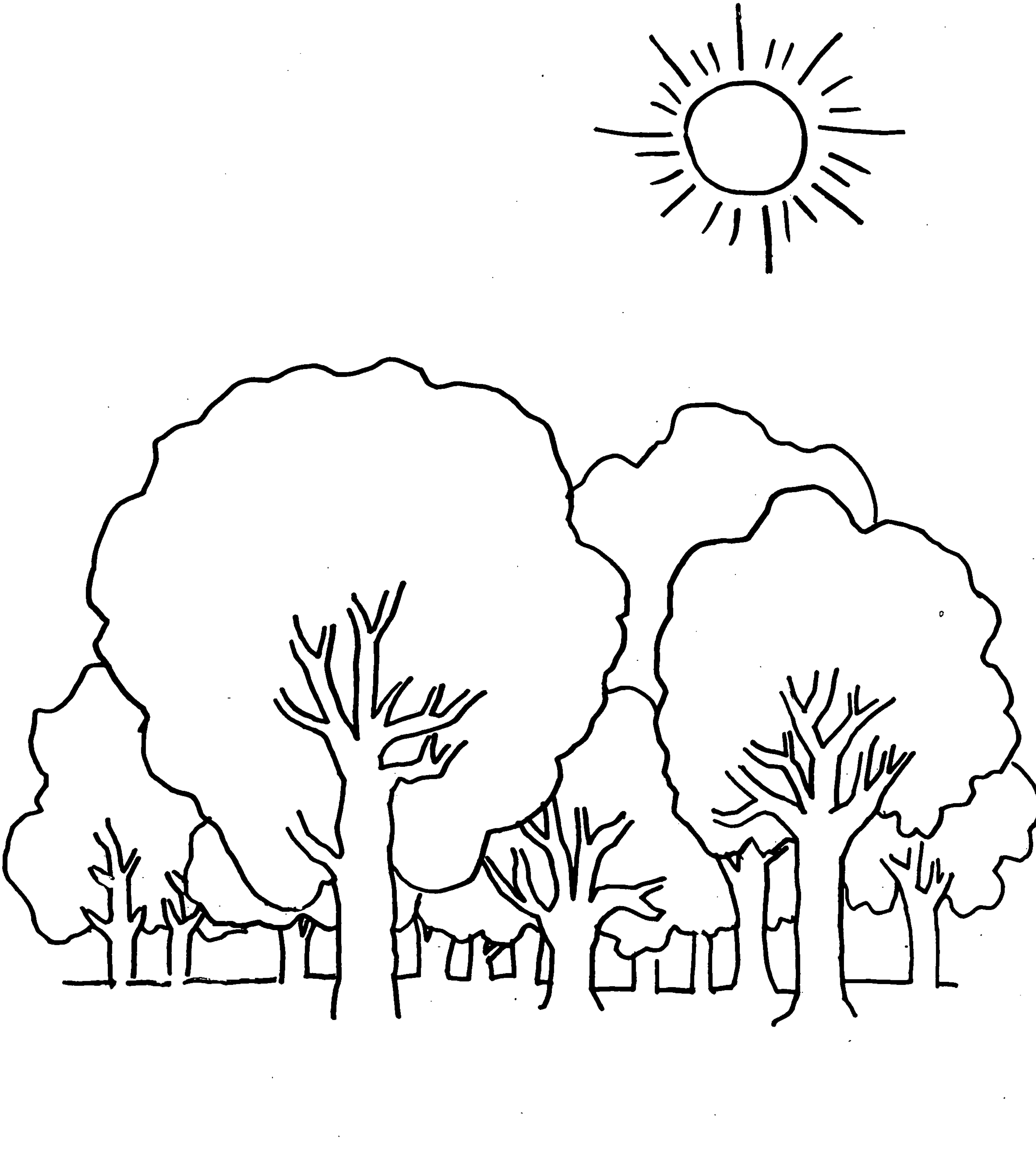




# FIFTH GRADE - LESSON 5
# ENERGY SOURCES AND CONSERVATION

## OBJECTIVE:

*The students will learn the definition of energy, types of energy sources, and ways to conserve energy every day.*

## PART I: BACKGROUND

### INTRODUCTION:

At present depletable resources, such as coal, gas, and oil, are the major sources of energy we depend upon. These fossil fuels will be depleted in several hundred years. Other major sources of renewable energy are available.

**I. Energy** - Energy is the ability to do work.

**A. Types of Energy:**

1. **Potential** or stored energy.
2. **Kinetic** or energy in motion.

As energy changes back and forth from potential to kinetic, no energy is lost or created. Also, when energy changes from one form to another (coal to electricity), no energy is lost or gained. This principle is known as the First Law of Thermodynamics. Energy can neither be created nor destroyed; it can only be changed from one form to another.

Most of the energy we use today comes from fossil fuels--coal, oil, and natural gas. Fossil fuels are captured solar energy. For thousands of years, when plants and animals died, layers of carbon rich matter accumulated and mixed with sand and mud. Heat and compression over time changed this material, buried deep under the earth, into pockets of coal, gas and petroleum.

**B. Energy Efficiency**

When energy is transformed from coal to electricity, some energy turns into heat. Sometimes this energy is referred to as "lost" energy even though it is not actually lost. It is referred to as "lost" energy because it is not usable as electricity.

**II. Fossil Fuels and Electricity**

When you flip on the light switch, you are using electricity that is produced mostly from fossil fuels. Coal, for example, can be burned at a power plant in a giant tub called a *boiler* that contains water. As the coal is burned, the water gets hot and turns into steam. This steam is piped into a turbine, which has blades that turn as the steam comes in, like blades on a windmill turn as the wind blows. The turning motion of the turbine blades causes a shaft to rotate a wire coil inside a magnet. This is the *generator*. An electrical current is created and collected by the coil of wire. The electricity is sent from the power plant to your home through wires strung on telephone poles. You use this energy when you flip on the lights, TV, and Nintendo.

**III. Sources of Energy**

All sources of energy are ultimately derived from the sun. For example, *biomass* is stored photosynthetic energy; in turn, wind and water currents are driven by the sun's thermal energy.

**A. Water power** is energy produced by falling or moving water. Rivers, ocean currents, waves and

*thermoclines* (abrupt changes in water temperatures) are all sources of water power. Hydroelectric plants use the flow of water to power turbines generating electricity.

1. Benefits: Hydropower is one of our greatest sources of energy--it supplies 1/4 of the world's energy! It also does not create pollution.

2. Problems: When dams are built, farmland, wildlife habitat, and residential areas are submerged. Reservoirs inevitably fill with silt deposited when upstream areas erode. This eventually can lead to flooding. Watersheds are disturbed, leading to destruction of wildlife habitat. Also, wild and scenic recreation areas are permanently altered.

B. **Solar Power** is energy produced by sunlight. Hot water and steam can be provided by collecting equipment that gathers the sun's heat and transfers it to water or steam. Photovoltaic cells produce electricity when sunlight shines on them.

1. Benefits: Solar power is an inexhaustible source of energy. It is also pollution-free, and involves no transportation costs, time, or energy.

2. Problems: Harnessing solar energy requires large equipment, partially because energy must be stored to compensate for cloudy days. This equipment is expensive and the production process requires energy and depletable resources.

C. **Wind Power** is energy produced by wind. Windmills produce mechanical energy from moving air. Frequently this energy is used to pump water from underground supplies. With numerous windmills, electricity can be produced.

1. Benefits: Like solar and water power, wind power is a clean, renewable source of energy. Windmills can pump underground water to the surface for crop irrigation.

2. Problems: Wind power, like solar power, is unpredictable. Means of storing the mechanical energy have not yet been created. Also, many windmills are required to produce electricity.

**D. Geothermal Power** is produced by the earth's heat. For every 30 meters down, the earth's temperature increases 1 degree Celsius.

1. Benefits: Like wind, water, and solar energy, geothermal energy is renewable and clean.

2. Problems: Harnessing geothermal energy is limited to locations where the earth's thermal energy can be accessed like volcanoes, geysers, and hot springs. Poisonous minerals like arsenic are often found in these areas and can contaminate water supplies.

**E. Fuelwood** is biomass like plants, wood, seaweed, and grain. The food we eat is biomass that our bodies convert to energy. Biomass is the energy source most heavily relied upon today; however, unlike solar, water, thermal, and wind energy it is readily depleted and requires effort to replenish.

1. Benefits: Fuelwood is easily converted to energy.

2. Problems: Fuelwood extraction is costly and degrades the environment. For example, mining results in deforestation, inversion of the soil profile, disturbance of vegetation and wildlife, erosion, and runoff.

**E. Nuclear Power** is a depletable source of energy produced from splitting uranium atoms.

1. Benefits: Only very small quantities of uranium are needed to produce proportionally large amounts of electricity.

2. Problems: Nuclear power plants generate radioactive wastes that must be disposed of. Since radioactive wastes are a health hazard and degrade slowly, disposal becomes a problem. Also, steam emitted from plants can be contaminated with radioactive material.

**F. Wastes** are a source of energy. Dung and solid wastes can be burned at combustion facilities to produce electricity. This is a relatively new process and is particularly promising since it responds to two needs simultaneously: solid waste disposal and energy production.

1. Benefits: Can reduce the volume of garbage.

2. Problems: Emissions from the incinerator stacks. And proper disposal of the ash residue to ensure that harmful substances in the ash will not be released into the ground water.

### IV. Resistance to Renewable Energy

Even though renewable energy harnessing techniques have been invented, conversion has been slow. Grants for research and development are given to large established firms instead of new and innovative firms. Converting to renewable energy resources requires a long-term financial committment whereas maintaining conventional power sources does not.

### V. Environmental Degradation

Processing, exploration, and extraction of natural resources causes disruption to ecosystem habitats and wildlife while degrading *flow resources* like water and air. Accidents caused by human and technological mistakes can cause long-term damage. Usually it is expensive and difficult to mitigate environmental degradation. Renewable resource consumption tends to be less degrading than depletable resource consumption.

Acid Rain - Acid rain results from burning fossil fuels. Smoke mixes with precipitation and falls to the earth, contaminating water supplies and damaging flora and fauna.

Greenhouse Effect - Fossil fuels release carbon dioxide when they are burned. This increases the carbon dioxide content of the earth's atmosphere, which traps heat near the surface of the earth, contributing to global warming. Warming trends can permanently alter the climate of biomes, resulting in extinction of plant and animal life.

Oil Spills - result from accidents during exploration for and transportation of petroleum. Oil slicks can kill marine mammals, fish and birds and are exceedingly difficult to clean up.

## PART II: METHOD

*Stand up! Spin around! Do ten jumping jacks! Run in place! Sit down!*

*What did you need in order to perform these activities?* Energy.

Plants need energy to grow and produce food. Animals need energy to move from place to place, to find food, to protect their young. You use energy to play, do homework, and sleep.

Let's look at some toys that use energy. (Show examples of poppers, spin tops, bouncing ball, etc.). Toys need batteries or people to make them move or work. Look around the room to see if you can find some energy users, like lights, heater, clock.

*What energy users did you use this morning before coming to school?* Refrigerator, microwave, stove, alarm clock, toaster, water heater, TV, radio. You have named many examples of items that use energy.

*Now can you come up with a good definition of energy?* Energy is the ability to do work.

*What is used to create the energy needed by the items you mentioned?* Fossil Fuels

Some examples of fossil fuels include oil and gas pumped from wells located under the earth and the sea floor. They can be shipped in pipelines and refined to various grades for different purposes. Coal is mined underground or from beds near the earth's surface. It can be used in its natural form or converted to a liquid or gas.

### I. Ways to Conserve Energy

Turn lights and TV off when no one is using them..
Carpool.
Turn off the water when brushing your teeth.
Use the light from a window.
Open refrigerator door as little as possible.
Hang clothes on a clothes line.
Use cold or warm water to wash clothes, not hot.
Take short showers.
Set thermostat to 65 degrees in the winter, lower at night.
Insulate your home and your hot water heater.

**II. Light Switch Reminder Activity**
(Adapted from *Turn Out Those Lights*, 1992)

Lighting offers a great opportunity to reduce energy use in schools since in most schools, lighting is one of the largest energy users, consuming from 38 to 54 percent of total classroom energy. Other energy users like heating/cooling systems and computer laboratories throughout the school consume greater amounts than classroom lighting, however, lighting is probably the largest energy user per classroom.

Make copies of the light switch patterns on paper already used on one side thus, saving energy and natural resources. Have the students cut the pattern out and decorate. Hang the light switch reminders around the school and at home as reminders to conserve energy.

**III. Pinwheel Activity**

Materials: (For each student)
2 straws
1 5" x 5" square paper
1 thumb tack
2 pieces of tape
crayons
ruler

**Procedure:**
**1.** Tell students to color their paper in any pattern or design.
**2.** When they are finished, tell them to measure and cut approximately 2 1/2 inches at each corner, towards the middle of the square.
**3.** Starting in one corner, tell the students to bring the tip of one corner to the center. Skip a tip and bring the next tip into the center. Skip a tip and so on until a pinwheel is formed.
**4.** Tape the tips together in the middle.
**5.** Next, stick a thumb tack through the middle of the pinwheel and into the straw.
**6.** Discuss how this pinwheel, like a windmill, uses a major form of energy (the wind) to operate.

*Do we use windmill energy today? Have we ever used windmill energy in the past?* The early pioneers of the Great Plains used windmills to pump up underground water to drink, feed their cattle, and irrigate. If you drive through Kansas, Nebraska, and Oklahoma you will see windmills still working today.

*What kind of work can windmills do?* Windmills can generate electricity or do mechanical work.

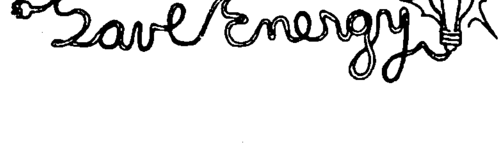
*Why don't we use wind as a major energy source today?* Since the amount of wind we get each day changes, the equipment must have the capacity to store energy or have backup systems. Plus, the initial installation is very costly.

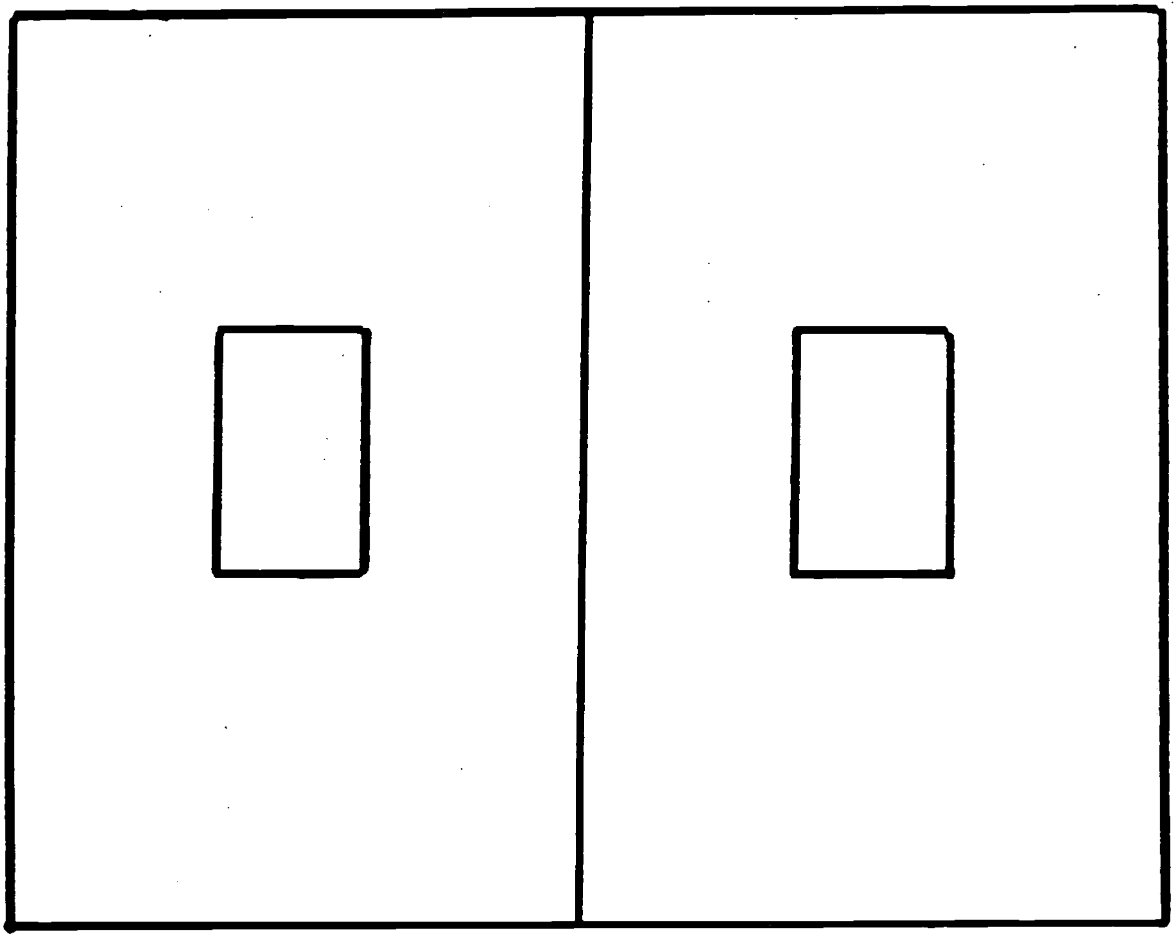
Explain the dilemma of the long-term financial investment.

**IV. Additional Activity - Purchase a hand-crank generator for students to discover the amount of energy required to create electricity**

*What do you think will happen if I turn this crank?* Electricity will be produced to light the bulb. Electricity is produced by moving a conducting wire like copper through a magnetic field. *Today we do not have to turn a hand-crank to create electricity, so where do we get the energy we use every day for lights and appliances?* We get our energy from fossil fuels like coal, oil and natural gas.

Explain how these fossil fuels were formed and how they are used to create energy. Show examples of coal. Examples of coal can be obtained free of charge from the American Coal Foundation (see references).





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# SIXTH GRADE - LESSON 6
# WATER QUALITY

## OBJECTIVE:

*The students will learn to identify and discuss sources of water pollution and ways to conserve water, and to identify some aquatic macroinvertebrates.*

## PART I: BACKGROUND

### INTRODUCTION:

The engineer, Thomas King, said, "Of all substances necessary to life - water is by far the most important, most familiar and wonderful; yet most people know very little about it."

Seventy-five percent of the earth's surface is water, but only a small fraction is usable by humans for drinking.

Ninety-seven percent = oceans
Two percent = ice caps and glaciers
One percent = usable surface water

With such a small percentage of the total water supply usable, it is important to conserve our water resources and to keep them clean.

### I. Conservation of Water

*Install a low-flow aerator to your shower head and to your kitchen and bathroom faucets.
*Check faucets for leaks. A faucet that drips once each second will waste more than 10 gallons of water every day.
*Use phosphate-free detergents.
*Turn off the water while brushing your teeth, washing dishes, and washing your hands.
*Never pour motor oil, or oil-based paints, into the ground. A single quart of motor oil can pollute 250,000 gallons of drinking water.
*Use your dishwasher and washing machine for full loads only.
*Store a container of water in your refrigerator for cold water.

### II. Water Use - How Much?

Water is not only necessary to all forms of life, it is also involved in both the natural and human production of non-living objects and materials.

10 gallons of water are used to produce 1 gallon of gasoline. Water is used in the purification process.

150 gallons of water are used to produce 500 sheets of paper. Water is used by trees and in pulp production.

300 gallons of water are used to produce 1 loaf of bread. This includes the water needed for the wheat plants to grow, water used in the processing of the wheat and flour, and water used in making the bread.

4000 gallons of water are used to produce 1 pound of beef. Cattle drink water, water is used at the slaughterhouse and grocery for cleaning.

The whole country consumes more than 450 billion gallons of water daily. A person can survive only 2 to 3 days without water, but can survive 1 to 2 months without eating food.

### III. Water Quality

Conducting a macroinvertebrate sampling is a good indicator of water quality in a freshwater stream. Macroinvertebrates are organisms lacking a backbone that are visible to the naked eye. They include crustaceans (crayfish), insects, mollusks (clams and mussels), gastropods (snails) and others. By

determining which kinds of macroinvertebrates inhabit a stream, one can get a good idea of the water quality. Generally, the greater the diversity of organisms, the better the water quality.

Streams are constantly changing. A section of stream polluted today may be flushed clean the following week. However, the effects of the pollution may be clearly identified by changes in the quantity and variety of the macroinvertebrates found. If a pollution problem occurs in the stream, it may take a considerable amount of time for the community of macroinvertebrates to regain its strength. Although each macroinvertebrate varies in its tolerance to low oxygen levels and high toxicity, most are highly sensitive to adverse conditions. Therefore, these organisms provide a good indication of stream water quality.

The majority of stream-dwelling macroinvertebrates live in riffle areas where there is a plentiful supply of oxygen and food. Riffles are caused by rocks and pebbles in the streambed. The optimum area to find macroinvertebrates is in riffles produced by ten-inch cobbles to one-inch gravel.

**IV. Causes of Water Pollution**- fertilizers, insecticides/pesticides, paint, automobile gasoline, detergent phosphates, sewage, heated water, acid rain caused by sulfur emission from coal-burning plants, and silt caused by soil erosion

## PART II: METHOD

*Guess what I am describing: It may be dreadfully silent or boastfully loud. It is strong enough to move huge mountains and carve great valleys, to turn heavy wheels and run powerful engines. Without it there would be no factories, jet planes, computers, video games, plants, animals, fish, insects... or people.* Water

Water is important not only to all living things, but also in the natural and human production of non-living objects and materials.

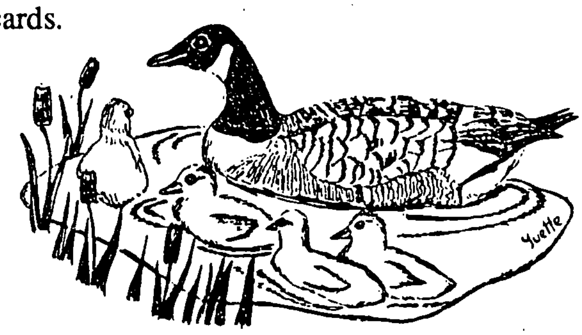
### I. Bucket of Water Activity

Take a five-gallon bucket and fill it with water (a five-gallon bucket filled with water weighs 40 lbs). Then try to carry it so that you don't spill any. Now talk about how silly it is to use ten gallons of water (double the amount in the bucket) to brush your teeth.

**II. Water Relay** (From *Bringing Water, Children, and Streams Together*, 1986)

**Materials:**
4 tin cans
30 5x7" index cards in two colors, one color for each team.

**Procedure:**
**1.** Mark 2 tin cans: Needs Water and 2 marked: Does Not Need Water.
**2.** Have students cut out and paste magazine pictures illustrating living and non-living natural objects and manufactured objects to index cards.
**3.** Divide the class into two teams and have each team line up single file at the starting line.
**4.** At the opposite end of each line, place two cans, one labeled Needs Water and one labeled Does Not Need Water.
**5.** Scatter index cards on the floor face down around the cans.
**6.** If the object described on the card needs water in order to exist or in order to be produced, place the card in the Needs Water can. If it does not, place the card in the other can. Have the first student on each team begin the race.
**7.** The winning team is determined not just by the best time, but also by the largest correct number of cards.

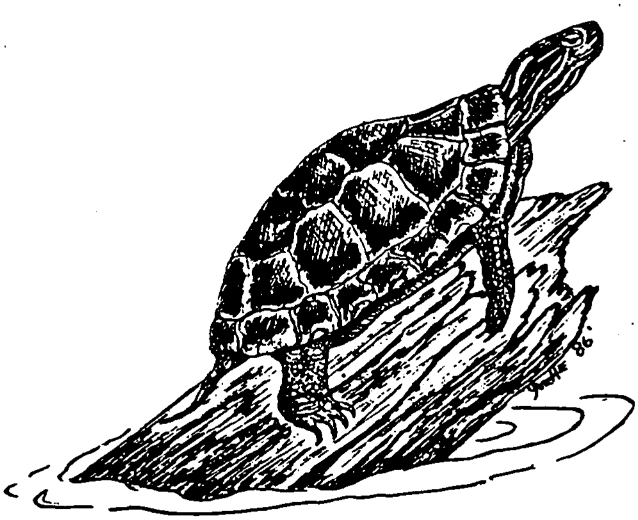


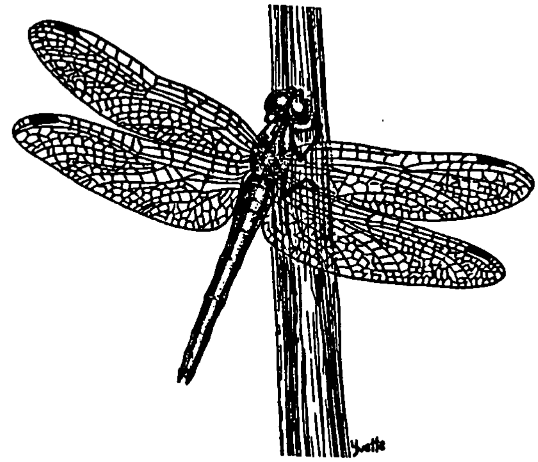
## III. Kick-Seine Activity

Water is considered to be polluted when it is unsuitable for the use it is intended to serve. Discuss different ways water becomes polluted, and what can be done to protect our water resources from becoming polluted. Then lead the discussion into macroinvertebrate sampling and how these organisms can give us a good idea of the quality of the water.

The kick-seining technique is a simple procedure for collecting stream-dwelling macroinvertebrates. It is used in riffle areas where the majority of the organisms live.

1. Locate a riffle area composed of rocks, ranging in size from ten inch cobbles down to one-quarter inch gravel. The water depth will range from a few inches to a foot, with a moderate swift flow.
2. After you have located a riffle area, select a collecting area measuring 3 feet by 3 feet that is typical of the riffle as a whole. Avoid disturbing the stream.
3. Approach the selected riffle area from downstream.
4. Have one person place the net at the downstream edge of the sampling area. Hold the net perpendicular to the flow, and at a slight downstream angle. Stretch the net approximately three feet and make sure the bottom edge is lying firmly against the stream bed. If water washes beneath or over the net you will lose organisms.





5. Standing beside the collecting area, begin to pick up the rocks in front of the net. Hold the rocks below the water surface and brush all organisms from the rock surface. The organisms removed from the rocks will end up in the net.
6. Next, step into the upstream edge of the collecting area and kick the stream bed vigorously. Kick from the upstream edge towards the net.
7. Carefully remove the net with a forward scooping motion. Do not allow water to flow over the top of the net or you may lose organisms.
8. Carry the seine to the side of the stream. Remove organisms from the net and place into small buckets to transport back to your ten-gallon tanks. See enclosed chart for identification. Remember to return organisms to the stream.

Allow students the opportunity to observe and identify the macroinvertebrates.

After observing the macroinvertebrates, view drops of plankton-filled pond water on a projecting microscope. Remind the students that they are looking at several drops of water from a pond, and that the life forms they are observing are smaller than the point of a pin.

*Is this water with all these creatures clean or dirty?* Let students debate. *If these creatures were not found, what would that mean? If we dump cleaning agents into the water, what does that make the water, clean or dirty?*

After debating, review how important it is to conserve and protect our water resources.

41


## LESSON 6 REFERENCES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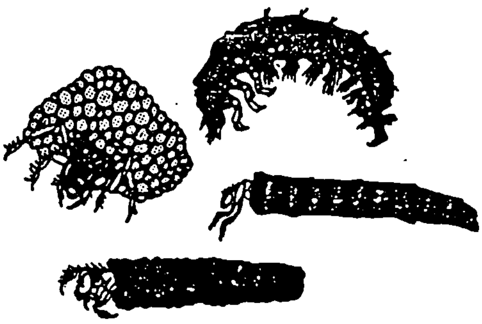
# MACROINVERTEBRATE IDENTIFICATION GUIDE

## GROUP ONE TAXA - pollution sensitive organisms

### Caddisfly larvae

*Order Trichoptera*

Key features:
- "worm-like" appearance
- 6 legs near head
- small tail hooks
- size range: 1/4" - 3/4"
- may be found in case

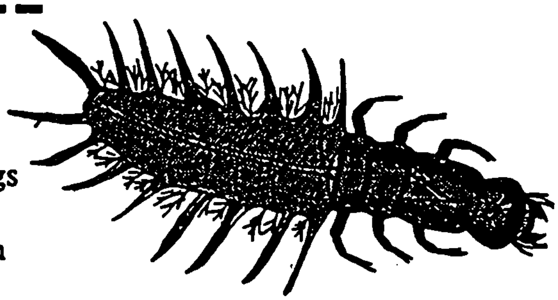


*Caddisfly larvae can often be found on the undersides of stones, protected by a collection of small pieces of stone, shells, or other materials which are held together by an adhesive substance that caddisfly larvae secrete. They may also be found in cylindrical cases which they make and wear for protection. They will retract into this case when threatened or startled. Body color of these larvae varies from yellow and green to brown. Note: These larvae tend to curl up slightly (as pictured) when placed on a flat surface.*

### Dobsonfly larvae

*Family Corydalidae*

Key features:
- set of "pincers"
- tail hooks
- stout body with 6 legs
- lateral appendages
- with gills underneath
- size range: 3/4" - 4"

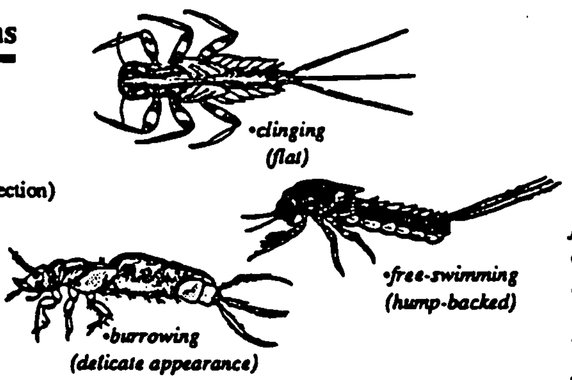


*Dobsonfly larvae are often found clinging to rocks in the more swift areas of the riffle. These larvae are predacious and spend much of their time hunting for prey. They have stout bodies with tough skin. The appendages on the rear section of this organism are called "lateral appendages" and should not be mistaken for legs. If you find a dobsonfly larva in your seine, grasp it directly behind the head to pick it up. This makes it impossible for the larva to pinch you. Note: These larvae are also known as "hellgrammites."*

### Mayfly nymphs

*Order Ephemeroptera*

Key features:
- 3 hair-like tails
  (these may break off during collection)
- 6 legs
- 3 basic types
  (pictured at right)
- size range: 1/4" - 1"

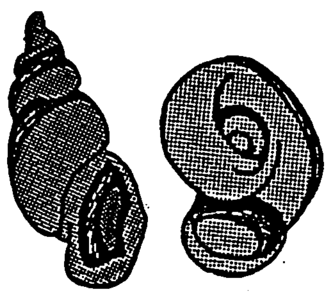



*The three basic types of mayfly nymphs are classified by their life style. Burrowing nymphs burrow in the stream bottom sediments and are typically longer and lighter in color than the other types of mayfly nymphs. Clinging nymphs have very long, fragile tails, and are typically brown like the rocks they "cling" onto. Free-swimming nymphs are fast swimmers and are usually dark colored. Colors among these three groups vary, but tan, brown and black are common. All three types share the characteristic of three tails, though tail length may vary. Note: Tails are most easily seen on a submerged organism.*

### Other snails

*Class Gastropoda*

Key features:
- shell opens to the right
  (see text)
- on most, a covering, called the operculum, indicates the snail is alive. If no operculum is present look for a fleshy "foot."

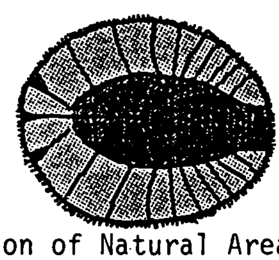


*Snails in this category can be distinguished from pouch snails by the opening of the shell. To identify a snail, hold it with the tip of the shell pointed up and the opening facing you (as pictured). If the opening is to the right side, you have a snail that falls in the "other snails" category, also referred to as the "gill-breathing" snails. Note: The flat, coiled snails also fall in this group. Do not count empty shells.*

### Water penny beetle larvae

*Family Psephenidae*

Key features:
- very flat
- oval or round in shape



*Water penny beetle larvae look like fossils as they cling to the undersides of rocks. These larvae are tan, brown, or black and round like a penny (though smaller). They are flat and have six small legs on their undersides. They are best found by direct inspection of rocks at the river's edge.*

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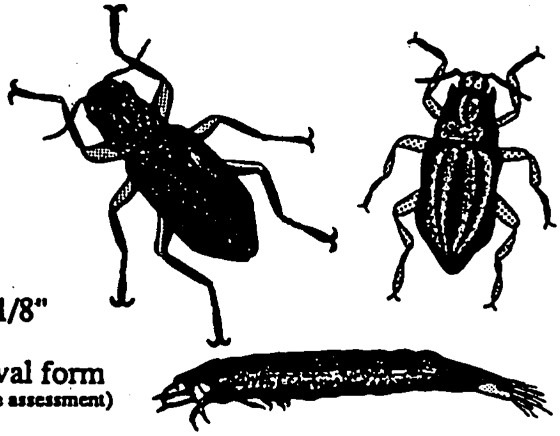
## GROUP ONE TAXA (continued)

### Riffle beetles
*Family Elmidae*

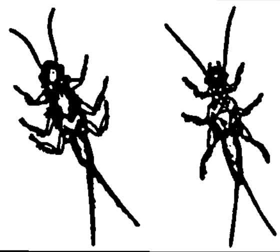
Key features:
- very small
- 6 legs
- size range: 1/16" - 1/8"
- may be found in larval form (this form is not counted in the assessment)



*Riffle beetle adults are very small and hard to spot because they are dark colored (usually black) and blend in well with chips of slate and dead leaves in the seine. To find these beetles, watch the seine closely for movement. Be careful not to mistake small terrestrial beetles for riffle beetles. If you are uncertain if you have a riffle beetle or a terrestrial beetle, put it in water. If it seems well adapted to water and fits the rest of this description, it is probably a riffle beetle. Please be aware of the appearance of the larval form so you do not confuse it with other organisms. Note: the larval form's hard exterior, cylindrical shape and the small tuft of white filaments which are present at the rear of the organism.*

### Stonefly nymphs
*Order Plecoptera*

Key features:
- two tails
- 6 legs
- size range: 3/16" - 1"

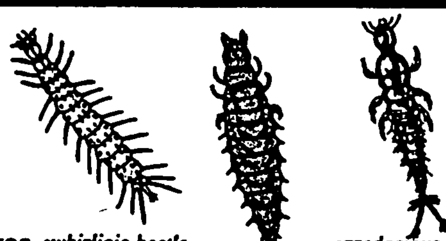


*Stonefly nymphs are structurally similar to mayfly nymphs, except that stonefly nymphs have two tails instead of three. They also appear somewhat less fragile than mayflies, because they possess a more rigid-looking exterior. They are often yellowish and brown or black in color and may be brilliantly patterned.*

## GROUP TWO TAXA - pollution intermediate organisms

### Beetle larvae
*Order Coleoptera*

Key features:
- head more slender than that of the dobsonfly
- 6 legs
- some with lateral appendages
- size range: 1/2" - 1"

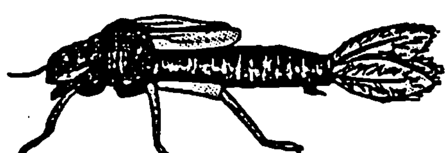


•whirligig beetle larva •water scavenger beetle larva •predacious diving beetle larva

*Beetle larvae look somewhat similar to dobsonfly larvae, but are generally smaller, lighter in color and more slender and tapered than the dobsonfly larvae. Often the head is darker in color than the rest of the body. Beetle larvae will not have the pronounced pincers that the dobsonfly larvae possess. The appendages on the back section (abdomen) of this organism, if present, are called "lateral appendages" and should not be mistaken for legs.*

### Damselfly nymphs
*Order Odonata*

Key features:
- 6 legs
- 3 feathery tails
- size range: 1/4" - 3/4"



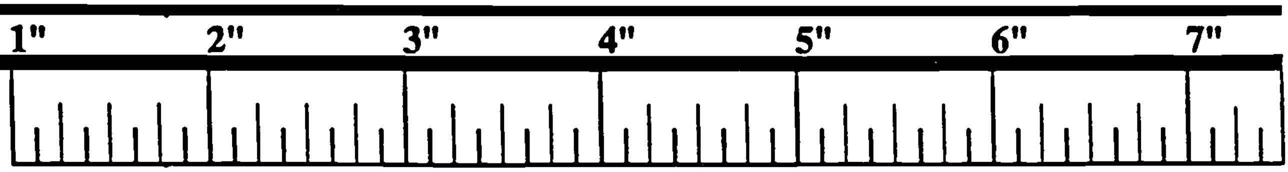
*Damselfly nymphs are somewhat slender, with six legs and three feathery tail appendages which are flat or fan-like and usually oval in shape. These tails are readily visible if the organism is placed in water. Damselfly nymphs are most easily found around stream vegetation and calmer areas along the stream's edge.*

### Dragonfly nymphs
*Order Odonata*

Key features:
- large eyes (like adult dragonfly)
- 6 legs
- often flat on underside
- no tails
- size range: 1/2" - 1 1/2"

*Dragonfly nymphs have the large eyes typical of the adult form and are often quite flat on their undersides. The abdomen may be stout and somewhat diamond-shaped. These nymphs do not have tails like those seen on the damselfly, mayfly, or stonefly nymphs. The body length may be up to 1", and the legs may be quite long. Some may look "spider-like". Like damselfly nymphs, they are most easily found near aquatic vegetation or in the calmer areas of the stream.*

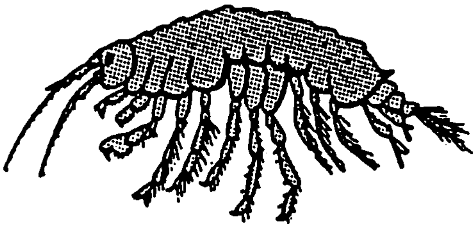
***Ruler***
Inches



## GROUP TWO TAXA - *(continued)*

### Scuds
*Order Amphipoda*

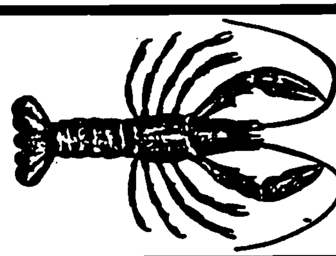
Key features:
- "shrimp-like"
- usually quite small
- size range: 1/8" - 1/4"



*Scuds look basically like little shrimp and they actually belong to the same subphylum , Crustacea. They have a swimming motion similar to that of crayfish, propelling themselves backwards through the water with quick strokes of their tails. They may be slightly orange or green and are somewhat translucent and shiny with some silvery-gray coloration.*

### Crayfish
*Order Decapoda*

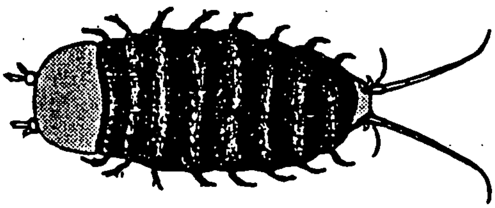
Key features:
- 10 legs, 2 with claws (unless broken off)
- size range: 1/2" - 5"



*Crayfish are quite easy to identify. They closely resemble a small lobster. They can be found under loose rocks in the middle or the edge of the riffle. They will swim swiftly backwards if frightened or disturbed. Note: Crayfish are also known as crawdads.*

### Sowbugs
*Order Isopoda*

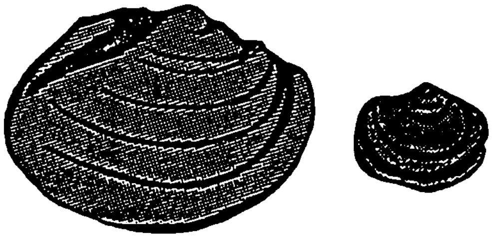
Key features:
- segmented, flat body
- many legs
- size range: 1/4" - 1/2"



*Sowbugs are gray and segmented, with an "armored" appearance. They look very similar to terrestrial sowbugs, also known as pill bugs. They have a sort of rectangular shape and many small legs. Sowbugs are most easily found along the stream's edge.*

### Clams
*Class Bivalvia (Pelecypoda)*

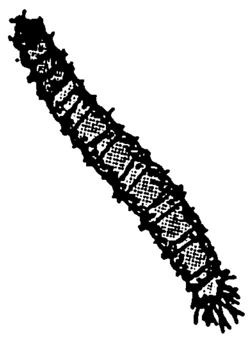
Key features:
- 2 hinged shells
- fleshy "foot" (not visible if shells are closed tightly)
- size range: 1/8 - 5"



*Clams are easily identified by their two shells which they will draw tightly closed when handled. Count only whole, live clams (those with both shells) in your assessment. Please do not force the shells open to see if you have a live clam. If the shell is tightly closed, you can assume the organism is alive. Note: Clams are usually buried in the stream bottom, so you should kick up the sampling area thoroughly. Also, as indicated by the size range, clams can be quite small and fragile, so look carefully and handle carefully. Do not count empty shells.*

### Crane fly larvae
*Family Tipulidae*

Key features:
- worm-like and plump
- no legs
- small tentacles at one end (these will extend if you give the larvae a gentle squeeze)
- size range: 1/2" - 2 1/2"



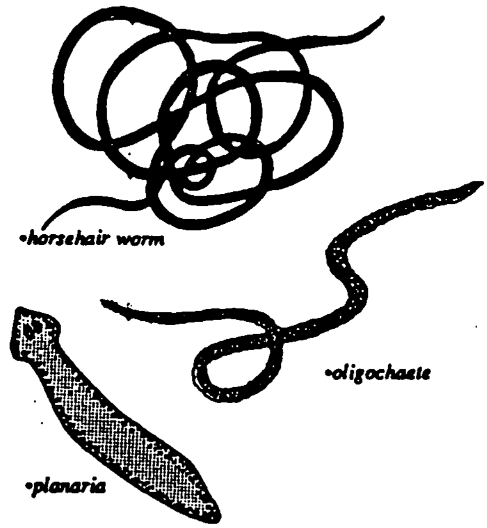
*Crane fly larvae are segmented and worm-like. They can be found in a large variety of colors, including white, brown, and green. Some are almost translucent, so you can see the insides of the organism move when it crawls. These larvae have a soft, fleshy appearance and very short tentacles (small "arms" or projections) at one end which can be seen more easily if the larvae is placed in water or squeezed gently. They range in length from 1/2" to 2 1/2" and may be as thick or slightly thicker than a pencil.*

**Please note:** If you find an organism which you cannot identify with this guide, please feel free to draw a sketch of it on the back page of your assessment form (please make a note on the front to direct our attention to the back of the page). We will then attempt to identify the organism at the office and contact you to let you know of the correct identification.

# GROUP THREE TAXA - pollution tolerant organisms

___ **Aquatic worms**
*Phylum Annelida and others*

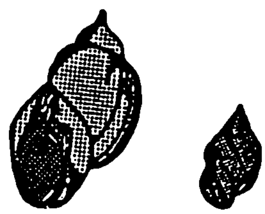
Key features:
- no legs
- may be smooth or bristly
- may be round or flat
- size range: 1/4" - 5"




*Many aquatic worms look similar to earthworms. In streams, you may also find very long, slender worms (such as horsehair worms), or flatworms, like planaria, which are small, sticky and soft-bodied (contrast with the muscular leech--see below). Many of these can slip through the seine quite easily, so watch closely. If you locate a worm and it is not a midge larva, crane fly larva, leech, or black fly larva, (see descriptions below and on previous page) it should be recorded under the category of "aquatic worms." These worms will typically "wriggle" in a snake-like fashion. Colors vary greatly in this category (red, white, and brown are common). Note: Worms do not have legs. If it looks like a worm, but has six legs ( they may be small) it is not an aquatic worm -- check the other descriptions to correctly identify the organism.*

___ **Pouch snails**
*Class Gastropoda*

Key features:
- shell opens to the left
- presence of a fleshy "foot" indicates the snail is alive.



*Snails in this category can be distinguished from "other snails" by the opening of the shell. To identify a snail, hold it with the tip of the shell pointed up and the opening facing you (as pictured). If the opening is to the left side, you have a pouch snail. Do not count empty shells.*

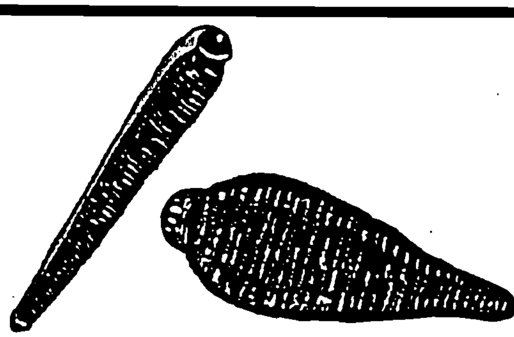
___ **Black fly larvae**
*Family Simuliidae*

Key features:
- quite small
- bulbous at one end
- constricted in middle
- size range: 1/16" - 1/4"

*Black fly larvae are small and slightly bulbous at one end. They use this bulbous end to attach themselves to rocks and other material, usually in the faster flowing areas of the riffle. They may be found in groups, attached to stones and leaves and will often curl into a "u" shape when pulled off and held in the hand. Most larvae are gray or brownish in color.*

___ **Leeches**
*Class Hirudinea*

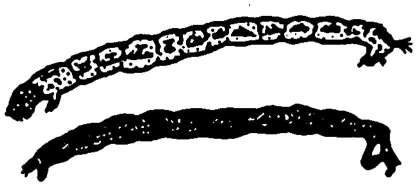
Key features:
- flat underside
- circular, sucking mouth
- size range: 1/2" - 4" when extended (see text)



*Leeches are usually small, dark in color, and flat. They tend to cling to smooth stones and boulders with their circular "sucker." Leeches generally have the appearance of being segmented, with the lines running perpendicular to the length of their body. They may be long and tapered, or short and tear-drop shaped. They move by extending and contracting their tough muscular bodies, so they may appear quite long. Do not confuse these with the flat, soft-bodied planaria (see above).*

___ **Midge larvae**
*Family Chironomidae*

Key features:
- often very small, slender
- spastic squirming action (see text)
- size range: 1/8" - 1/2"



*Midge larvae are often a distinct red color, though they can also be brown or even whitish in color. The best way to identify these larvae is by their small size and spastic squirming action. Note: These are very small, slender organisms, so watch your seine closely and make a point of inspecting leaves and other debris which may be present.*

*This identification sheet was designed by the staff of the Division of Natural Areas and Preserves with assistance from volunteer Anne Coburn for use with the Ohio Scenic Rivers Stream Quality Monitoring Program. Our thanks to Anne and to all our dedicated volunteers.*

Brukner Nature Center

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